THE ADVANCEMENT OF SCIENCE

VOL. VI, No. 22 JULY, 1949

CONTENTS

PAGE

Officers and Council 84

The X-Ray Analysis of the Structure of Penicillin, *by* mrs. dorothy hodgkin, f.r.s. 85

Activities of Unesco in the Natural Sciences during 1948 90

The Economics of Strategic Dispersal, *by* prof. brinley thomas 105

Movements of Atoms in Crystals, *by* mrs. kathleen lonsdale, f.r.s. 112

Mobility in the Location of Industry in Great Britain, *by* wilfred smith .. 115

Shortage of Scientific and Technical Books 117

The Administration of Large Scale Enterprises, *by* j. c. picton 119

Rural House Types, *by* prof. r. a. cordingley and m. marcel maget .. 123

Horticultural Crops in Relation to Water, *by* f. a. secrett, c.b.e. .. 128

Science in Adult Education—Report of a committee 131

Air Photography and Geology—Report of a discussion 146

Malnutrition and Resistance to Infection, *by* prof. j. r. marrack 151

Education : Topical Problems 153

Associations for the Advancement of Science 167

OFFICERS AND COUNCIL OF THE BRITISH ASSOCIATION, 1948–49

PATRON.

HIS MAJESTY THE KING.

PRESIDENT.

Sir JOHN RUSSELL, O.B.E., F.R.S.

GENERAL TREASURER.

M. G. BENNETT.

GENERAL SECRETARIES.

Dr. EDWARD HINDLE, F.R.S. | Sir RICHARD SOUTHWELL, F.R.S.

ORDINARY MEMBERS OF THE COUNCIL.

Sir EDWARD APPLETON, G.B.E., K.C.B., F.R.S.
Prof. F. BALFOUR-BROWNE
Prof. J. D. BERNAL, F.R.S.
M. C. BURKITT.
Prof. D. BURNS.
RITCHIE CALDER, C.B.E.
Wing-Comm. T.R. CAVE-BROWNE-CAVE, C.B.E.
Prof. W. E. LE GROS CLARK, F.R.S.
Prof. WINIFRED CULLIS, C.B.E.
Dr. C. D. DARLINGTON, F.R.S.
Sir CHARLES DARWIN, K.B.E., F.R.S.
Dr. H. J. T. ELLINGHAM.
Prof. C. B. FAWCETT.
Dr. K. G. FENELON.
Prof. P. SARGANT FLORENCE.
Dr. J. C. MAXWELL GARNETT, C.B.E.
Dr. O. J. R. HOWARTH, O.B.E.
Prof. E. H. NEVILLE.
Sir WILLIAM OGG.
Dr. S. J. F. PHILPOTT, M.C.
Lord RENNELL OF RODD, K.B.E., C.B.
Sir JOHN SIMONSEN, F.R.S.
W. O. LESTER SMITH, C.B.E.
Dr. C. J. STUBBLEFIELD, F.R.S.
Dr. H. HAMSHAW THOMAS, M.B.E., F.R.S.
Dr. C. TIERNEY.
Dr. A. E. TRUEMAN, F.R.S.
Prof. R. G. WHITE.
Dr. H. E. WIMPERIS, C.B., C.B.E.
Prof. A. W. WOLTERS.

EX-OFFICIO MEMBERS OF THE COUNCIL.

Past-Presidents of the Association, the President for the year, the President and Vice-Presidents for the ensuing Annual Meeting, past and present General Treasurers and General Secretaries, and the Local Treasurers and Local Secretaries for the Annual Meetings immediately past and ensuing.

PAST PRESIDENTS OF THE ASSOCIATION.

Sir CHARLES S. SHERRINGTON, O.M., G.B.E., F.R.S. (1922).
H.R.H. The DUKE OF WINDSOR, K.G., F.R.S. (1926).
Sir ARTHUR KEITH, F.R.S. (1927).
Field-Marshal The Rt. Hon. J. C. SMUTS, O.M., P.C., C.H., F.R.S. (1931).
Sir RICHARD GREGORY, Bt., F.R.S. (1940–1946).
Sir HENRY DALE, O.M., G.B.E., F.R.S. (1947).
Sir HENRY TIZARD, G.C.B., F.R.S. (1948).

PAST GENERAL OFFICERS OF THE ASSOCIATION.

Prof. P. G. H. BOSWELL, O.B.E., F.R.S.
Prof. F. T. BROOKS, LL.D., C.B.E., F.R.S.
Sir DAVID BRUNT, F.R.S.
Prof. ALLAN FERGUSON, D.Sc.
Sir HAROLD HARTLEY, K.C.V.O., C.B.E., M.C., F.R.S.
Sir JOHN LENNARD-JONES, K.B.E., F.R.S.
Sir JOHN L. MYRES, O.B.E., F.B.A.
Sir FRANK SMITH, G.C.B., G.B.E., F.R.S.
Prof. F. J. M. STRATTON, D.S.O., O.B.E., F.R.S.

HON. AUDITORS.

Dr. EZER GRIFFITHS, F.R.S. | R. S. WHIPPLE.

SECRETARY.

D. N. LOWE, O.B.E.

THE X-RAY ANALYSIS OF THE STRUCTURE OF PENICILLIN

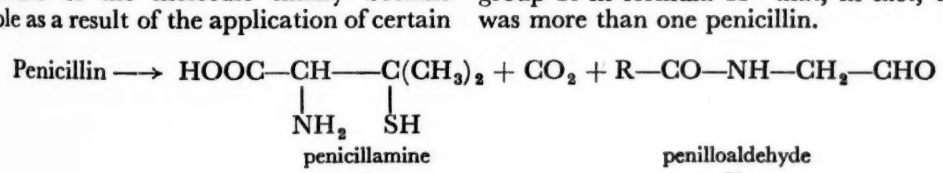
BY

DOROTHY CROWFOOT HODGKIN, F.R.S.

In the investigation of penicillin, X-ray crystallographic methods have been used to work out the actual chemical structure of the molecule, the way in which the atoms, known by chemical analysis to be present, are bonded together in space to give the compound its particular chemical and biological properties. This working out of chemical structures is not a new thing in X-ray analysis—the very first X-ray analysis ever carried out by Sir Lawrence Bragg established the chemical structures of sodium and potassium chloride in an essentially similar way, by showing the distribution of the atoms in space and the distances between them. But there was something new in the case of penicillin in the complexity of the problem handled and in the way in which the X-ray studies were woven into the rest of the chemical investigation.

There was also something new, although it was hidden at the time by war-time secrecy, in the dramatic way in which the chemical structure of the molecule finally became visible as a result of the application of certain very recently introduced techniques of X-ray analysis.

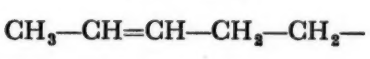
The first use of X-ray diffraction data in the study of penicillin began before any penicillin was crystallised. In the summer of 1942, Dr. Chain and Dr. Abraham at Oxford isolated a substance, penicillamine hydrochloride, by the breakdown of the penicillin molecule. Some evidence on the approximate size of this molecule, which contained rather less than half the number of atoms in penicillin, was obtained by X-ray methods. But its structure in detail was established as shown below (I) by chemical synthesis before even the data necessary for its X-ray analysis could be collected. And the same was true for the different degradation products derived from the other half of the penicillin molecule, and particularly of the penilloaldehydes (II). Here perhaps the main value of the X-ray data was in helping to show that penilloaldehydes, and consequently penicillins were liable to vary with the source of the preparation due to variations in the structure of the group R in formula II—that, in fact, there was more than one penicillin.



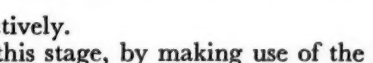
penicillamine I.

penilloaldehyde II.

With the first crystallisation of a penicillin salt in July 1943 at the Squibb Institute in America, a critical advance in the knowledge of penicillin chemistry was possible. News of this crystallisation reached this country by cable, and within a couple of days it was found that the sodium salt of the Oxford penicillin also crystallised very easily, in fact spontaneously, if exposed to moist air. It was, however several weeks before direct comparison, by X-ray and other methods, of the two crystalline salts which had been produced in America and England showed that they were certainly different. And it was the work of a couple of months more to prove that the American sample consisted of sodium benzylpenicillin, $C_{16}H_{17}O_4N_2S.Na$ (penicillin II or G as it was then called) while the Oxford sample was sodium 2-pentenylpenicillin, $C_{14}H_{19}O_4N_2S.Na$ (penicillin I or F), the R groups of formula II above being

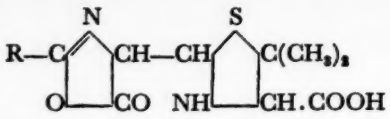


and

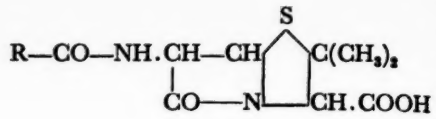


respectively.

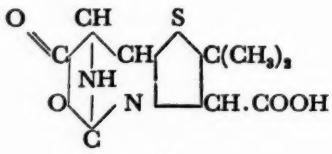
At this stage, by making use of the knowledge of the degradation products of penicillin previously obtained, it was possible to write out likely chemical formulae for the active molecule. Those that seemed most probable to different chemists at the time are the three given below: III, the thiazolidine oxazolone; IV, the thiazolidine β-lactam; V, the tricyclic structure.



III.



IV.



V.

There was considerable hope at this period, October 1943, that one or other of these structures would be found by synthesis to be that of the active molecule and that, as in the case of penicillamine hydrochloride, the penicillin problem would be rapidly settled by the established methods of organic chemistry.

At the same time, the crystallisation of the penicillin salts made possible a direct attack by X-ray methods on the molecular structure. This attack did not, at first, appear to be at all hopeful. Of the two salts examined, the sodium salt of benzylpenicillin had the simpler crystal structure, as Table I shows, but the solution even of this structure presented a difficult problem. It required finding positions within the space of the measured crystal unit for the 24 heavier atoms of the molecule, positions such that they would account for the varying intensities of some 400 or more observed X-ray diffraction spectra.

To test by calculation atomic arrangements based on any one of the proposed formulae would have been formidable ; it seemed almost impossible in view of the varying character of the formulae actually proposed. The detailed X-ray analysis therefore began rather slowly. We in Oxford (Dorothy Crowfoot Hodgkin and Barbara Low) who had so far carried out all the X-ray measurements, asked first for more material and particularly for more salts of penicillin. By April 1944 we had received 10 mgr. of sodium benzylpenicillin from the Merck Laboratories (U.S.A) and rather more potassium benzylpenicillin from the Squibb Research Institute (U.S.A.) and rubidium benzylpenicillin from I.C.I. Dyestuffs Division (England).

Our reason for asking for the potassium and rubidium salts was that we hoped they would be isomorphous, and that from the relation between the intensities of the X-ray diffraction effects from the two salts we should be able to deduce not only the amplitudes but also certain phase angles appropriate to the diffracted beams. With a knowledge both of the phases and amplitudes of the diffraction spectra, we should be able to calculate the electron density in the crystals by the mathematical summation of Fourier series as originally described by Sir William Bragg. We ought then to be able to see the atoms present in the structure as peaks of high electron density. As things happened, the two salts were isomorphous and a certain number of phases could be directly found as we had hoped, but not by any means all. And, as a result of the limited data we could use, the first electron density maps which we calculated in the form of projections of the structure on different crystal faces were very imperfect. They gave only a very blurred picture of the atomic distribution, so blurred that we could tell nothing for certain about the molecular structure, not even approximately the shape of the molecule.

In the meantime, another line of attack was developed on the sodium salt of benzylpenicillin. This new line of attack was due to the introduction by Sir Lawrence Bragg of the idea of testing trial structures by using optical diffraction instead of calculation and to the development of this idea by C. W. Bunn into a practicable and rapid method of X-ray analysis. The sodium salt of benzylpenicillin was not isomorphous with the potassium and rubidium salts. Though closely related in crystal structure, it had a smaller unit cell of lower symmetry and this made it easier to handle in a trial analysis. Mr. Bunn put his experience at our disposal and we gradually began a period of close collaboration with him. We passed the data we had collected on the sodium salt into his hands and with Miss A. Turner-Jones he continued the analysis of the sodium salt while we worked on the remaining two in Oxford.

Bunn's approach was further encouraged by the fact that at this time (summer 1944) one structure, the oxazolone structure, seemed very likely to be correct. Attempts at its synthesis had already given products showing traces of biological activity. Bunn therefore based his trial structures on the oxazolone formula and found an arrangement for

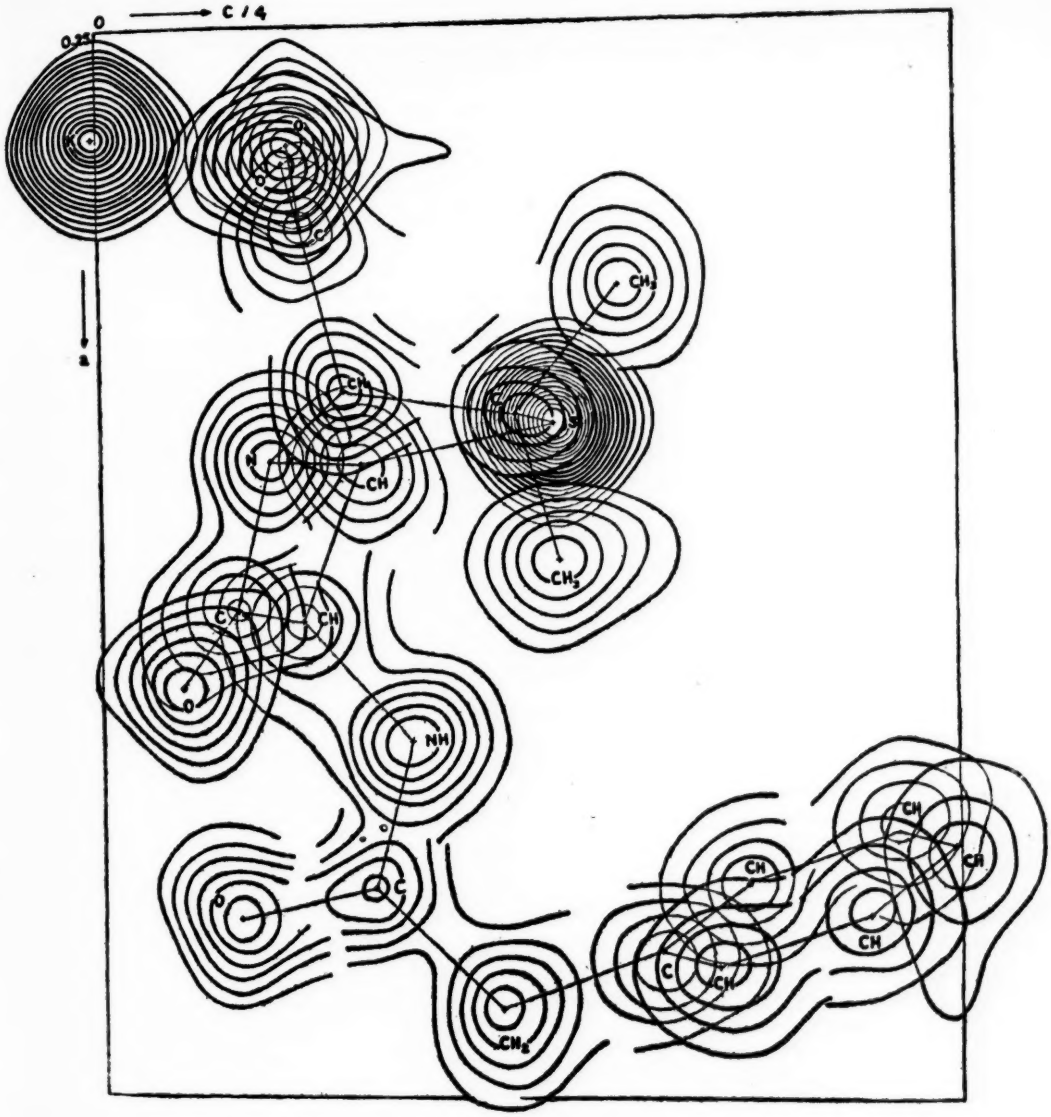


FIG. 1.—The atomic positions in potassium benzylpenicillin shown projected on the *b* plane. These positions are derived from the second three dimensional electron density series. The contours drawn are those which show the calculated electron density at levels parallel to the projection plane passing at or near the atomic centre. The contours are drawn at intervals of 1 electron per A^3.

the molecule which gave some agreement with the observed X-ray intensities. Since he could not improve this agreement by trial, he calculated phases for the intensities based on his trial structure and derived a first electron density projection based on these phases. But this projection looked very unlike the trial structure used in its preparation and no refinement of the projection appeared possible in terms of the trial structure.

At this point there was something of a deadlock. On the chemical side, evidence had accumulated against the oxazolone structure; but none of the other formulae appeared wholly satisfactory. On the crystallographic side, it was clear that none of the trial atomic arrangements so far examined could be correct. Yet all the evidence necessary to solve the three different crystal structures had been collected and there were a number of clues to the correct solution. The clearest evidence of this solution appeared dramatically when the data on the three salts were set side by side. Two of the trial electron density projections of the potassium and rubidium salts and the one obtained from the sodium salt all gave roughly correct

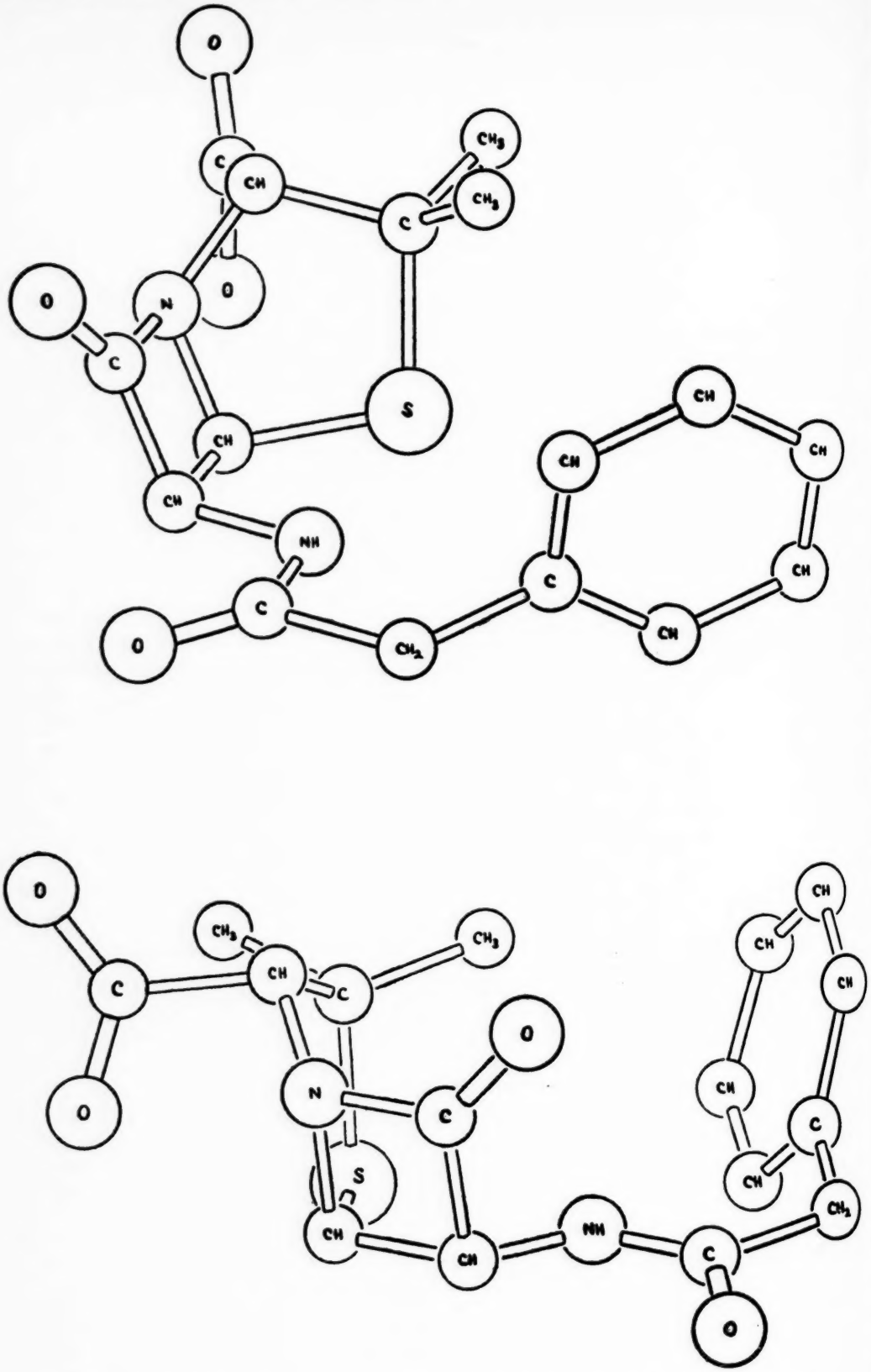


FIG. 2.—Diagram to show the arrangement of the atoms in the benzylpenicillin ion. The two views shown are derived from the atomic co-ordinates found in the sodium salt by C. W. Bunn.

but blurred pictures of the same view of the molecules. In these pictures, however, the molecules were differently arranged, as required by the difference in crystal symmetry between the sodium salt and the other two. We realised that owing to this difference it was possible to find out directly the shape of the molecule in the crystal by comparing the two series of projections. Only peaks which had the same relation to one another in the different projections could constitute one molecule. This direct comparison showed us that the molecule was roughly semicircular in projection, 'curled up' as we came to call it. And once the shape of the molecule was realised, it was easy to fit over the electron density contours many of the atoms known from degradation experiments to be present—all the atoms of the pencillamine skeleton and the benzyl group.

From this date—the end of January 1945—progress was exceedingly rapid. The process of the improvement of both the electron density projections of the potassium and rubidium salts and of the sodium salt proceeded independently and led almost simultaneously to the same conclusions. At first atoms were placed over the electron density contours in positions that corresponded as nearly as possible with a curled up oxazolone structure; new phases were calculated and new terms introduced into the Fourier series. But as the electron density outlines improved and individual atoms became visible, they also moved and the positions of the peaks changed to correspond with those required for one of the other formulae, the β-lactam formula for penicillin. Within a fortnight the situation had changed out of recognition. And by May 1945, when other projections had been examined, the chemical structure of penicillin was virtually settled.

In all the electron density projections a certain amount of overlapping of atomic peaks occurs which makes it difficult to place the atomic centres exactly. The individual atoms could only be seen clearly separate by the calculation of the electron density in three dimensions and this calculation was accordingly undertaken for the sodium and potassium salts. It is a far heavier calculation than any that had up to that time been carried out in any X-ray analysis and was only achieved through the support of the Medical Research Council which procured for us the professional assistance of Dr. Comrie and Mr. Hey of the Scientific Computing Service.

In the final electron density series calculated for sodium and potassium benzylpenicillin all the heavier atoms in the structure can be seen individually and the atomic arrangement is established as that required by the β-lactam formula for penicillin in one particular stereochemical form.

These points are illustrated by Fig. 1, which shows a composite drawing of the atomic positions found in the three dimensional electron density distribution calculated for the potassium salt. Here, one set of electron density contours, surrounding each atomic centre, are projected on to one of the crystallographic planes most used in the first stage of calculations. In three dimensions, the way in which the atoms must be bonded together can easily be traced from the size of the electron density peaks and their relative distances apart. In the diagram, directions of chemical bonding are drawn as fine lines which show the four membered β-lactam ring, the five membered thiazolidine ring and the benzene ring at a considerable angle to the plane of projection. The positions of the hydrogen atoms follow in most cases from chemical rather than X-ray considerations, though there seem to be some indications also of their presence in the electron density series. As a whole the conclusions of the X-ray analysis can be seen very clearly in the diagram of the molecule shown in Fig. 2. This illustrates both the carbon nitrogen oxygen sulphur skeleton found and the stereochemical relations between the different interatomic bonds.

There is naturally much other evidence in favour of the β-lactam structure for penicillin, collected by the united work of the many hundreds of chemists who combined together in its investigation during the war. This evidence has not been discussed here. So far the investigation has not led to the synthesis of penicillin by a process that would unambiguously settle its structure, and this is not surprising in view of the awkward form of the molecule described above. Rather it is surprising that such molecules should crystallise in crystal structures as beautiful and satisfactory as those which have been found by X-ray analysis.

TABLE I.—*Unit Cell Dimensions of the Salts of Penicillin.*

	a.	*b.*	*c.*	β.	Space Group.	*n.*
Sodium 2-pentenyl penicillin	37·08	6·0	18·4	106°	C2	8
Sodium benzyl penicillin	8·48	6·33	15·63	94·2	$P2_1$	2
Potassium benzyl penicillin	9·36	6·37	30·35	—	$P2_12_12_1$	4
Rubidium benzyl penicillin	9·45	6·44	30·2	—	$P2_12_12_1$	4

ACTIVITIES OF UNESCO IN THE NATURAL SCIENCES DURING 1948

FOREWORD

BY

PROF. E. D. ADRIAN, O.M., F.R.S.

THE United Nations Educational, Scientific and Cultural Organisation (UNESCO) was established in 1946 as an intergovernmental organisation pledged to the development through international action of education, science and culture. Though Governments provide its funds and, in the main, determine its policies, the Organisation differs essentially from all other Specialised Agencies of the United Nations in the fundamental importance which it attaches to the part which non-governmental institutions can play in its work. The principle of partnership between governments and the free and voluntary institutions of education, science and culture, is embodied in the National Commission which Member States are obliged by the Constitution to set up in their territories. The United Kingdom National Commission for Unesco was established over two years ago by the Minister of Education. It operates through a number of specialised committees or co-operating bodies each representing one of the main subject fields for which the Organisation is responsible. The Minister of Education entrusted the responsibility for the Section on Natural Sciences to the Royal Society which accordingly established the British Committee for Co-operation with Unesco in the Natural Sciences to act as the responsible body.

At a recent meeting the Committee had before it the following report describing the work carried out by the Natural Sciences section of Unesco in 1948. As the scope of this work is not always understood, the Committee felt that the report would be of interest to British scientists generally, since it summarises what has been done and gives a list of all the grants in aid (totalling $238,374) made to the International Unions for conferences, publications, etc.

These grants represent the aspect of Unesco's work which will be most familiar to scientists, but the Department has also an important responsibility for the exchange of scientific information, material and personnel between the more and the less scientifically developed regions of the world. The Field Science Co-operation Offices have been established for this purpose and their work is described on pp. 91 and 92. The sum appropriated for the Field Science Offices for 1949 is $221,856 as against $242,374 for the grants in aid.

The total appropriation for the Natural Sciences section for 1949 is $679,505. The financial resources of the Organisation are not, however, unlimited. Indeed, in face of the vast problems before it, they are small. It is, therefore, essential that they be used for purposes widely recognised as the most urgent and yet the most practical. By bringing this account of Unesco's work to a wide range of British scientists and by seeking their comments and suggestions upon it, the British Committee hopes that it will be possible to improve the programme. Over a period of years, a considerable amount of money and effort will be spent by Unesco on science in its international aspects and it must remain the responsibility of scientists everywhere to ensure that it is being spent on work that really matters and that offers hope of practical results.

On behalf of the British Committee, may I invite comments and criticisms from all readers of *The Advancement of Science*? They should be addressed to The Secretary, British Committee for Co-operation with Unesco in the Natural Sciences, Ministry of Education, 23 Belgrave Square, London, S.W. 1. (Sloane 4522.)

E. D. ADRIAN,
Chairman, British Committee.

I. INTRODUCTION

The Department of Natural Sciences is one of seven programme departments which constitute the Secretariat of Unesco. The expenditure of this Department in 1948 amounted to $864,655 out of a total expenditure of $6,696,800. Its staff numbered 38 out of a total staff of 664. Eighteen nationalities were represented on this staff as follows : Australia 2; Belgium 2 ; Canada 1 ; China 4 ; Czechoslovakia 1 ; Denmark 1 ; Egypt 1 ; France 7;

Hungary 1 ; India 3 ; Italy 1 ; Norway 1 ; Republican Spain 1 ; Sweden 1 ; Switzerland 1; United Kingdom 7 ; United States 2 ; U.S.S.R. 1.

The fields of scientific knowledge represented are : Aeronautics 1 ; Agricultural Chemistry 1 ; Biochemistry 3 ; Chemical Engineering 1 ; Civil Engineering 2 ; Experimental Biology 1 ; History of Science 1 ; Mathematical Statistics 1 ; Mechanical Engineering 1 ; Neurophysiology 1 ; Physics 6 ; Plant Physiology 1 ; Plant Pathology 1 ; Pathology 1 ; Scientific Documentation 1 ; Scientific Journalism 2.

A list of the documents prepared by the Department during 1948 is contained in an Appendix.

In the following parts of this Report upon the activities of the Department in 1948, references are made to certain resolutions. The texts of these will be found in ' Documents Relating to the Second Session of the General Conference of Unesco, Mexico City, November, 1947 ' (H.M.S.O., price 1*s.* 6*d.*). The corresponding resolutions of the Third Session held in Beirut, November 1948, will be found in ' Proceedings of the Third Session of the General Conference, Vol. II, Resolutions ' (H.M.S.O., price 3*s.* 6*d.*), and the Report of the United Kingdom Delegation thereon in White Paper Cmd. 7661 (H.M.S.O., price 9*d.*).

In the following report of activities during 1948, Resolutions of the Second Session of the General Conference held in Mexico City in November 1947 are indicated by numbers in parenthesis.

II. SCIENCE CO-OPERATION OFFICES

The General Conference, recognising that the Organisation must maintain the closest contact with specialists in various countries, instructed the Director-General to maintain field science co-operation offices in the Middle East, the Far East, and Latin America and to establish an office in South Asia in 1948, as undertakings of the highest priority within the Natural Sciences programme (Res. 6.1). These four offices, with the assistance of a headquarters staff in Paris, are engaged in collecting, exchanging and disseminating scientific information and materials between these regions and other countries. Wherever the facilities permit, questions are answered on the spot by the Field Officers, but there is a continuous flow of enquiries reaching headquarters, and these are handled with the aid of the Department staff and by reference to appropriate scientific institutions of Member Governments, to the United Nations and Specialised Agencies, and to private scientific institutions. Direct collaboration between the four Science Co-operation Offices is being carried out, especially between the three in the eastern hemisphere, which have many common problems.

A. Latin America

(formerly Rio de Janeiro, since November 1948, Montevideo)

In Natural Sciences perhaps the most outstanding event was the establishment of the first international regional research institute under the auspices of a United Nations organisation, in the shape of the International Institute of the Hylean Amazon (IIHA), to undertake research and surveys on problems of the equatorial forest zone. As a result of a conference held at Iquitos, Peru, in April and May, a draft Convention and a first year's budget for the Institute were agreed upon and an Interim Commission set up, with headquarters at Manaos, Brazil. Mr. Corner, formerly Principal Field Scientific Officer, was appointed Executive Secretary of the Commission. (See also Part VI, C.)

From the beginning this office was entrusted with the important task of exploring the ground for the establishment of an International Institute of the Hylean Amazon, and accordingly suspended a long term programme of scientific liaison in matters of documentation, flow of materials and specimens, exchange of information, etc. However, the visits of the officers to the various governmental and scientific institutions in the Latin American countries have awakened the interest of the countries on the exact nature of Latin American scientific liaison work in that vast part of the world where the problems of communications and co-ordination are considerable.

The Unesco-sponsored Latin America Conference on the Development of Science was held in Montevideo, Uruguay, in September 1948 (Res. 6.2). The Conference reaffirmed the usefulness of the Latin American Office and agreed that it could, with advantage, be transferred from Rio de Janiero, where it had been temporarily established in 1947, to Montevideo. Since November this office has been established in Montevideo and the field officers are, at present, carrying on the normal work of a Science Co-operation Office.

B. East Asia
(Nanking and Shanghai)

In war-devastated countries such as China and the Philippines, demands upon a Science Co-operation Office are particularly heavy. This office has established numerous contacts and has undertaken the important responsibility of allocating and distributing in the region the $2,000,000 worth of educational engineering equipment purchased by UNRRA. This has necessitated maintaining a branch office in Shanghai in addition to the office in Nanking. Ninety-nine allocation agreements were signed covering 414 tons of supplies and 370 tons of this were despatched to twenty-nine Chinese universities by August 1948. Since then, as far as possible, this work has been intensified and more of the equipment was allocated and installed because it was planned to terminate the whole operation by the end of January 1949.

The Field Officer has visited the Philippines, where he attended the FAO [1] Conference at Baguio and visited ten scientific institutions. On his return to Shanghai he visited the universities in Hong Kong, Amoy and Foochow. Exchange of scientific periodicals is being arranged by this office with institutions in Czechoslovakia, France, India, Italy, the Middle East, Central Europe, North European countries and Latin America.

In November the equipment of the Nanking Office was shipped to Shanghai to meet any further emergency. Further contracts have been made with Governments and scientific institutions in the Philippines, Indo-China and Siam.

C. South Asia
(New Delhi)

This office was established in April 1948 to cover Afghanistan, Burma, Ceylon, India, Indonesia, Pakistan and Siam. Keen interest has been shown by scientists of this area in the work of the office. The difficult problem of housing space was met by the generosity of the University of Delhi. The Field Officer has been to Karachi, where he visited the Division of Education of the Government of Pakistan, the Pakistan Development Board, the Public Service Commission and Sind University.

The Principal Field Scientific Officer had, from the beginning, the genuine support of the scientists with whom he came into contact in the region. He visited Simla and has made scientific contacts in Singapore, Burma, Malaya and Siam besides many places in India. He has received requests for reconstruction materials and for technical information on such matters as rubber and penicillin production in different countries. As time goes on an increasing flow of requests for material and technical help is coming in and towards the end of 1948 a Field Scientific Officer was appointed to join the Principal Field Scientific Officer in the work of this office.

D. Middle East
(Cairo)

The development of the Middle East Science Co-operation Office has proceeded steadily. Excellent working collaboration has been established with the local office of FAO. Contacts have been made with scientists in Cyprus, Egypt, Iran, Iraq, Lebanon, Syria, Transjordan, Turkey and Sudan. Everywhere the office has met with welcome and co-operation. The following typical questions have been dealt with : information on central institutions of scientific research, psychotechnical methods, treatises on scientific advances during wartime, stations for selection of sugar-cane, institutes working in phytopathological research, acclimatisation of cattle in the tropics, fixation of sand dunes, equipment for the dairy industry. Specimens of Salmonella choleræ susi, grafts of avocado, breeds of sugar-cane, Vicia faba and dimethylsilicon have been exchanged. Reprints of a pamphlet dealing with bilharziosis have been received through the Latin American office.

This office is encouraging the formation of local scientific societies, which will facilitate the exchange of information in the area. The first and second number of a ' List of Scientific Works published in the Middle East ' have been produced and distributed by the office. This is the beginning of a flow of general information which it is hoped will also be of use in other parts of the world.

III. PURE SCIENCES

The tasks of Unesco in this field in the main are : (*a*) to promote international co-operation and understanding among scientists, and (*b*) to support the free and peaceful pooling and collaborative use of known data for human welfare. These objectives are pursued by means of : (*a*) grants-in-aid to international non-governmental or self-governmental organisations

[1] Food and Agriculture Organisation.

that are covered by a formal agreement with Unesco, (*b*) contracts with organisations that do not have formal arrangements with Unesco, and (*c*) Unesco sponsored conferences and meetings. Unesco, however, does not directly sponsor or undertake original basic research itself. (Res. 6.6.1, 6.6.3, 6.8.)

In 1948 the grants-in-aid to the International Council of Scientific Unions and the ten Unions it federates amounted to $238,374. These grants helped the realisation of about 120 different projects, the meeting of about 450 scientists at about 50 international scientific conferences, the publication of some forty reports, bulletins, journals, etc., and the work of some thirty international scientific services, laboratories and stockrooms.

The grants were broken down among the recipients as follows :—

		$
ICSU	(International Council of Scientific Unions)	29,854
IUPAP	(International Union of Pure and Applied Physics)	17,300
IAU	(International Astronomical Union)	21,880
IUSR	(International Union of Scientific Radio)	9,000
IUCr	(International Union of Crystallography)	8,000
IGU	(International Geographical Union)	4,000
IUC	(International Union of Chemistry)	12,725
IUGG	(International Union of Geodesy and Geophysics)	34,270
IUBS	(International Union of Biological Sciences)	24,245
IZSN	(International Zoological Station, Naples)	10,000
ICZ	(International Congress of Zoology)	3,000
ICZN	(International Congress of Zoological Nomenclature)	10,600
ICGen	(International Congress of Genetic)	4,000
ICEnt	(International Congress of Entomology)	3,000
IAMB	(International Association of Microbiologists)	25,900
IHAS	(International High Altitude Station, Jungfraujoch)	4,000
IUTAM	(International Union of Theoretical and Applied Mechanics)	7,200
IUHS	(International Union of the History of Science)	9,400
		$238,374

The grants-in-aid to I.C.S.U. and its ten federated Unions can be further broken down as follows :—

	1948 $
Transportation expenses for meetings of Symposia, Commission, etc.	39,044
Transportation expenses for meetings of General Congresses and General Assemblies	44,040
Travel Grants	10,400
Publications	52,930
Permanent International Services	40,500
International Laboratories and Stockrooms	40,400
Administrative overheads granted to ICSU (for administering the grants)	11,060
	$238,374

The approximate distribution among the sciences is as follows :—

	Per Cent.
Physical, Celestial, Earth and Chemical Sciences	46·9
Biological Sciences	37·0
Other Pure Sciences (including History of Science)	16·1

In 1948 Unesco was especially interested in the development of the International Union of the History of Science which was established in 1947. Five Commissions have been set up to deal with (*a*) History of the Social Implications of Science, (*b*) Teaching of the History of Science, (*c*) History of Science in the Middle East, (*d*) Bibliography, and (*e*) Publications. During the year, 17 National Groups for the History of Science have been formed and have affiliated with the Union. The International Society for the History of Medicine has also become an affiliate of the Union. The various Unions federated by ICSU have taken steps to form Committees on the History of Science with special reference to their subject fields.

A contract was concluded with the Seventh Pacific Science Congress, for inviting a number of scientists from war-devastated countries of Asia and Europe to attend the Congress at Auckland and Christchurch, New Zealand, in February 1949. The Society of Visiting

Scientists in the United Kingdom prepared for Unesco a report on the purposes and mode of operation of the Society. The compilation of a Directory of International Scientific Organisations was initiated and its publication in English and French is scheduled for 1949.

In order to study the effects of high altitude on life, and physical phenomena observable only at high altitudes, Unesco convened a conference in 1948 with a view to making recommendations to Unesco and to the United Nations concerning international research stations of this type (Res. 6.4). With the assistance of Swiss authorities, and of the research station at Jungfraujoch, the International Conference on High Altitude Research Stations was held at Interlaken, Switzerland, August 31–September 3.

The delegates at the Conference agreed that if plans for research laboratories and observatories under the auspices of the United Nations were adopted, a high priority should be given to high altitude stations. In the meantime they resolved that the International Council of Scientific Unions might appropriately set up a mixed commission, composed of the International Astronomical Union, the International Union of Pure and Applied Physics, the International Union of Geodesy and Geophysics, and the International Union of Biological Sciences, to facilitate exchange of information. They further decided that organisations interested in international scientific co-operation should be asked to give support, both moral and financial, to this work. The Conference agreed that the existing high altitude stations of the world, and additional stations to be established, should be organised into a network. The delegates also proposed that grants for travelling expenses should be provided to selected scientists anxious to visit high altitude stations for research and study.

Unesco was represented at meetings of the International Council of Scientific Unions (Brussels), the International Union of Theoretical and Applied Mechanics (London), the International Union of Scientific Radio (Stockholm), the International Commission on Optics of the IUPAP (Delft), the World Federation of Scientific Workers (Prague), the British Association for the Advancement of Science (Brighton), the Symposium on Scientific Research sponsored by the Centre National de Recherche Scientifique (Paris), the American Physical Society (Pasadena) and the British Atomic Scientists' Association (London).

IV. APPLIED SCIENCES

A. Agricultural Sciences

During 1948, enquiries were made on the organisation of agricultural scientists, especially at an international non-governmental level. To assist the study of the complex problems involved, reports were commissioned, to be prepared by an expert in the U.S.A. and in the U.K. Several consultations were held between members of the Secretariats of Unesco and FAO in Paris, Rome and Washington. Contact was maintained with the French National Committee on Agricultural Sciences which is interested in the formation of an International Union of Agricultural Sciences which would be directed towards international co-operation in the pure sciences fundamental to agriculture. (Res. 6.6.2.)

Unesco provided grants-in-aid to the International Union of Biological Sciences for two symposia relating to the agricultural sciences : (*a*) biological control of pests, and (*b*) interaction between eggs and sperms in animal reproduction. (Res. 6.6.1.)

Towards the end of 1948, the FAO approached Unesco for assistance in maintaining and operating the Library of the International Institute of Agriculture in Rome. Unesco approved an emergency grant of $15,000 for this purpose for the year 1949, an equal amount being provided by the FAO. A Joint FAO-Unesco Committee on the IIA Library was established with members from FAO, Unesco and the Italian Government.

Unesco was represented at the FAO Conferences on Fisheries, Nutrition and Rice held at Baguio (Philippines) and on Forestry at Teresopolis (Brazil), and at the Fourth Session of the FAC General Conference in Washington. An observer attended the following meetings : Provisional Committee for the formation of an International Union of Nutritional Sciences (Cambridge), the 8th International Congress of Genetics (Stockholm) and the 10th Working Congress of the International Union of Forestry Research Organisations (Zurich).

B. Engineering Sciences

Considerable progress was made during 1948 on the classification of problems relating to international co-operation in the field of the engineering sciences (Res. 6.6.2). Several outstanding personalities in the engineering world were commissioned to prepare reports suggesting methods of bringing about effective collaboration on an international plane such as has been achieved in the pure sciences. Contact with existing international non-governmental organisations was maintained.

Unesco granted consultative status to the World Power Conference and the World Engineering Conference. A contract was made with the World Engineering Conference to assist with the publication of the papers to be presented at the Second World Engineering Congress in March 1949 in Cairo. The World Power Conference was granted a contract to aid in the publication of its first post-war Statistical Yearbook on Energy Resources. These publications will be of special significance to the United Nations Scientific Conference on Conservation and Utilisation of Resources to be held in 1949. At the invitation of the Economic and Social Council, Unesco has actively participated in the preparations for this Conference (Res. 6.9.1).

Work continued on a directory of engineering organisations on an international and national level. A contract was made with the World Engineering Conference to assist with this project.

Unesco was represented at the International Congress of Architects (Lausanne), the Third Congress of Bridge and Structural Engineering (Liège), and at the meetings of the Executive Board of the World Engineering Conference (Paris).

C. Medical Sciences

Excellent progress was made during 1948 on developing more effective international co-operation in the field of the medical sciences. The project of a Permanent Council for co-ordination of International Congresses of Medical Sciences has become a joint activity of Unesco and of WHO,[1] in accordance with resolutions adopted by the General Conference of Unesco at its Second Session and by the Interim Commission of the World Health Organisation at its Fifth Session (Res. 6.6.2). The Interim Commission of WHO voted $15,000 for participation in this project in 1948.

A meeting of the Organising Committee of the Permanent Council was held at Unesco House in April 1948. An Executive Committee was formed with the tasks of (1) calling a General Constituent Assembly early in 1949 for the setting up of the Permanent Council ; (2) preparing a draft constitution for the Permanent Council ; and (3) collecting information on the structure of the existing international organisations in the field of the medical Sciences. The first meeting of the Executive Committee was also held in April.

At the second meeting of the Executive Committee, held in October 1948, the draft constitution of the Permanent Council was adopted ; and after examination of the collected documentation sent by the international organisations, lists of active members and of associate members to be invited to the General Constituent Assembly were drawn up. It was decided that the General Constituent Assembly would be held at the beginning of April 1949 in Brussels. Invitations to the Assembly have been sent out to 52 international organisations, including some in the field of sciences fundamental to medicine. The First World Health Assembly held in June 1948, made a budgetary allocation for 1949 of $20,000 for continuing this project as a joint activity.

Unesco was represented at the Executive Board meetings and at the First Health Assembly of the WHO (Geneva) and observed the International Congress on Mental Health (London) and the Health Congress at Harrogate, U.K.

(For activities in the field of medical abstracting services, see Part V, A.)

V. SCIENTIFIC LITERATURE, APPARATUS (SAIS) AND RECONSTRUCTION

A. Scientific Literature

A Committee of nine experts from Czechoslovakia, France, the Netherlands, Sweden, the United Kingdom and the U.S.A. met at Unesco House in April to discuss problems of abstracting common to the various fields of pure and applied sciences (Res. 2.3.3.3.1). In general they approved the plans of the Secretariat for an International Conference on Science Abstracting to meet at Unesco House from June 20 to 25, 1949. Invitations to send representatives were sent to Member States of Unesco, Member States of the United Nations not members of Unesco, the United Nations and its Specialised Agencies, and suitable international organisations such as the international scientific unions and the International Federation for Documentation. The latter Federation is meanwhile carrying out a survey of science abstracting services on Unesco's behalf, and an expert is preparing working papers for the Conference.[2]

In accordance with a recommendation of a Preparatory meeting held at Unesco House in October 1947, an Interim Co-ordinating Committee on Medical and Biological Abstracting

[1] World Health Organisation.

[2] This Conference has now been held.

was set up and held its first meeting at Unesco House in April 1948 (Res. 2.3.3.3.3). It was attended by representatives of *Abstracts of World Medicine, Biological Abstracts, British Abstracts, The British Medical Journal, Chemical Abstracts, Excerpta Medica,* The Medical Library Association (U.S.A.), The International Federation of Library Associations, The International Federation for Documentation, and the World Health Organisation.

At this meeting, an Executive Committee was set up ; and resolutions were passed that (1) WHO and FAO be invited to join Unesco in sponsoring the activities of the Interim Co-ordinating Committee, and (2) the Committee be enlarged to include representatives of the following six abstracting services or national groups : Bureau of Hygiene and Tropical Diseases, Commonwealth Bureau of Animal Nutrition, one representative of the medical and biological abstracting services in France, the American Medical Association, International Abstracts of Surgery, Chemical Abstracts.

The first meeting of the Executive Committee was held in October 1948.

In accordance with the recommendations of the April meeting, (1) invitations to join the Committee were sent out to the services designated ; and (2) a request to join Unesco in sponsoring the activities of the Committee was forwarded to WHO and FAO. The Executive Board of WHO, at its Second Session, allocated a sum of $6,000 for its participation in this activity in 1949. The FAO designated a representative to attend the meetings of the Interim Co-ordinating Committee and of its Executive Committee ; (3) a statement on the activities of the Committee was drawn up for publication in scientific journals.

A meeting of representatives of the French medical and biological abstracting services was held in June 1948 and two representatives were nominated to serve on the Committee. The six abstracting services in the biological and medical sciences accepted the invitation sent to them in November and designated delegates to attend the full meeting in June 1947.[1]

As a result of the April meeting and of the preparatory meeting in October 1947, a small-scale experiment in co-operation has been initiated by four abstracting services.

The Unesco Libraries Division has arranged for the International Federation for Documentation to undertake comparative studies of classification systems and the revision of the Universal Decimal Classification. Interim reports have been received from the FID and indicate substantial progress.

An expert is preparing a report on multilingual scientific and technical dictionaries in which he will criticise existing dictionaries for two or more languages, indicate what subject and language combinations are most in need of new dictionaries, and consider the advantages of different forms of multilingual dictionaries.

Unesco was represented at the Restricted Conference of the International Federation for Documentation (The Hague), and at the Royal Society Scientific Information Conference (London).

B. Scientific Apparatus Information Service (SAIS)

It was during the Conference of Allied Ministers of Education (CAME) in London, when many requests were received for information on scientific equipment, that the idea of an international non-commercial Scientific Apparatus Information Bureau was conceived. The Science Commission of CAME responded to such requests as best they could and, when the latter was liquidated, suggested that Unesco should organise a similar service which would be of great help to scientists all over the world.

The first Session of the General Conference (Paris 1946) accepted this suggestion and authorised the Secretariat to set up a Scientific Apparatus Information Service (SAIS) in 1947. But this could not be carried out as the staff then available was entirely occupied with the urgent task of scientific reconstruction of war-devastated countries to which a higher priority was accorded. Nevertheless, the Second Session of the General Conference (Mexico City 1947) endorsed the approved activities of SAIS and included them in the programme of 1948 (Res. 6.8).

This novel service, potentially a large one, has been organised during 1948 as outlined in document Unesco/NS/45. Its scope is deliberately limited to answering queries concerning scientific and technological equipment for education and research in the pure and applied sciences. It is also being equipped to satisfy the strong need which exists among scientific men for information on the new materials and appliances which have been developed in recent years. The equipment of SAIS, though rudimentary as yet, consists of : (*a*) up-to-date catalogues of the principal scientific manufacturers of the world and information on the newest developments in the field of instruments ; (*b*) important periodicals dealing with scientific instruments ; (*c*) technical journals published by the leading industrial concerns ;

[1] This Conference has now been held and a Permanent Co-ordinating Committee is in being.

(*d*) a card-index of scientific instruments with the necessary cross-references, and related to a World Index of Scientific Manufacturers.

In order to enhance the efficiency of SAIS and extend the available services of information, assurances of close co-operation have been obtained from sixteen representatives of scientific manufacturers from nine leading countries, at a specially convened meeting at Unesco House in June 1948. Such contacts are being further extended to include universities, research associations and international scientific unions.

In addition to providing technical assistance in operating the Science Credit Scheme for the purchase of equipment for the war-devastated countries, SAIS responded during 1948 to queries from the Science Co-operation Offices, science institutions and individual scientists. Details of close co-operation are being worked out with WHO and other specialised agencies to supply similar information in such branches of sciences as are of direct interest to them.

The Department of Reconstruction arranged for the publication in English of a book entitled ' Suggestions for Science Teachers in Devastated Countries ' by J. P. Stephenson. It will be published in Arabic, Chinese and Spanish.

There has been a long-felt need, among science teachers the world over, for an internationally agreed standard of basic equipment for the adequate teaching of science in all its main branches in primary and secondary schools, universities and technical colleges. The urgent necessity of rehabilitating scientific education in the war-devastated countries has further strengthened the demand for such lists of basic scientific equipment for the teaching of science. This document, when made available extensively and in different languages, is expected to go a long way towards making science degrees and diplomas equivalent, irrespective of the college or the university where they are awarded.

Funds have been made available to have these inventories translated from English into French, Spanish, Chinese and Arabic, and to have them printed in English, French and Spanish in the course of 1949.

C. Scientific Reconstruction

The Mexico City Conference authorised the expenditure of $210,000 for the purchase and shipping of equipment for educational reconstruction during 1948 (Res. 1.5.1.1). Later in 1948, an additional $100,000 became available for the same purpose, by transfer of unspent funds from other Departments of Unesco, making a grand total of $310,000 for the year. Further funds were allocated for re-equipping the Academia Sinica in China ($8,405), and the Nencki Institute in Poland ($8,383).

During 1948 funds for scientific reconstruction were spent according to a new scheme, under which credits were allocated to institutions in the war-damaged countries through their Ministers of Education for the purchase of scientific equipment through Unesco, thus giving the beneficiaries the means of selecting the kind of equipment most needed, within the limits of the funds available.

The distribution of funds was decided by the Cultural Reconstruction Committee of the Executive Board according to the following tables :—

Reconstruction Fund 1948
$210,000

	Per Cent.
China	21
Poland	18
Greece	10
Czechoslovakia	9
Philippines	9
Italy	8
Hungary	8
Austria	7
Reserve 10 *per cent., later allocated to* :—	
Iran	5·3
Indonesia	4·7
TOTAL	100

Supplementary Reconstruction Fund 1948
$100,000

	Per Cent.
China	18
Poland	16
Greece	8
Czechoslovakia	8
Philippines	7
Italy	7
Hungary	7
Austria	7
Iran	7
Indonesia	7
France	7
TOTAL	100

It was suggested to the Ministers of Education that approximately half of the funds allocated to them should be used for the purchase of scientific equipment (to include packing and shipping charges estimated at 10 per cent. of the cost of equipment). This suggestion was accepted by Greece, Italy, Indonesia and France, while China, Poland, the Philippines, Austria and Iran preferred to increase the allotment for scientific equipment and Hungary proposed to devote nearly all of its funds to scientific purchases. Czechoslovakia, on the other hand, preferred to reduce expenditure on equipment in favour of books.

The final allocation of funds for Scientific Reconstruction, as well as the position at the end of 1948, is shown in the following table :—

1948 *Unesco Funds* ($210,000 + $100,000)

Country	Scientific Fund	Orders placed at end of December 1948	Remarks
	$	$	
China	45,500	21,000	Orders being drawn up from remainder of lists.
Poland	31,600	32,000	Purchases completed.
Hungary	18,400	12,350	No more lists available.
Philippines	17,900	10,300	No more lists available.
Austria	12,790	nil	Quotations from U.S.A. awaited.
Greece	12,600	1,310	Quotations from U.S.A. awaited.
Greece : Vocational Schools	4,410	nil	Quotations from U.S.A. awaited.
Iran	14,300	14,200	Purchases completed.
Italy	10,350	11,986	Purchases completed.
Czechoslovakia	8,600	9,876	Purchases completed.
Indonesia	7,390	nil	Awaiting approval.
France	3,150	nil	Awaiting lists of requests.

A Committee of experts on the production of scientific equipment representing eleven countries, met in June to discuss problems of scientific reconstruction in war-damaged countries, including availability of scientific equipment in various countries, means of overcoming delivery delays, and shipping problems. The Committee approved in principle the Unesco Science Credits Scheme (document UNESCO/NS/47), which proposed that within limits of allocated funds the selected war-devastated countries may order, through Unesco, needed scientific and educational equipment.

In August 1948 a sum of £60,000 from the Lord Mayor's United Nations Appeal for Children was allocated to Unesco, 50 per cent. of which was made available for educational equipment, including scientific apparatus and visual training aids ; four-fifths of this 50 per cent. to be used, wherever possible, for scientific equipment for schools, (secondary, vocational and professional) and other educational institutions, and one-fifth for audio-visual aids. Out of the total of £24,000 funds were allocated as follows :—

	Per Cent.
Poland	16
Greece	16
British Colonies	15
Italy	12
Malta	10
Czechoslovakia	8
Austria	7
Hungary	6
Transportation and coverage	10
	100

VI. SPECIAL PROJECTS

A. Popularisation of Science

The Director-General was instructed to stimulate by all possible means the popularisation of science (Res. 5.6). The need for improving the dissemination to the general public of information on new scientific and technological discoveries, and to spread an understanding of the scientific attitude and methods was stressed by the expert panels which Unesco called together in Paris and New York in 1947. Assistance in carrying out the work of this programme was provided by the Department of Mass Communications during 1948.

Several experts were commissioned to prepare reports on the ways of popularising science through the press, radio, films, museums and cheap books. These reports will be prepared for distribution during 1949 and will be of special value to technically less-advanced countries. Further steps were taken to establish world-wide co-operation between science clubs and associations of scientific writers to promote the preparation and exchange of material that will contribute to the general aim. A survey was made of popularisation of science activities in the U.K. and the U.S.A.

Assistance was given to the Lebanese Government in preparing a Scientific Exhibition which opened in November during the Third Session of the General Conference in Beirut. The Exhibition consisted of sections dealing with atomic energy, history of Arabic science, history of language, writing and numbers, and educational and vocational guidance.

Unesco was represented at the Second Annual Congress of the International Scientific Film Association (London).

B. Social Implications of Science

Preparations were made, in co-operation with the Departments of Mass Communications and of Social Sciences, for initiating in 1949 discussion groups in Member States on the first Unesco theme on the social implications of science. The theme selected for 1949 was FOOD AND PEOPLE. Recommendations have been made to Member States to organise debates and discussions both at the academic level, among scientists, economists and sociologists, and at the popular level among the general public (Res. 5.6.4).

A number of background papers on the various aspects of food and population have been planned and arrangements have been made with specialists of international repute to prepare them.[1]

Member States have been requested to supply Unesco with reports on the outstanding results obtained from the discussions. The project has been conducted in close consultation with FAO and the Population Division of the U.N. Economic and Social Council, and all material collected will be made available to the United Nations and the other Specialised Agencies.

The work of the ICSU Commission on Science and its Social Relations, the IUHS Commission for the History of the Social Implications of Science and of the World Federation of Scientific Workers and the World Engineering Conference was closely followed.

C. International Institute of the Hylean Amazon (IIHA)

The Second Session of the General Conference stipulated that Unesco's rôle in the setting up of the Institute was to initiate and stimulate, without financial commitment beyond 1948. It further stated that field survey staff should be provided from 1948 funds and that the services of the Science Co-operation Office in Latin America should be available to the Institute and to its Interim Commission (Res. 6.3).

The Conference for the creation of IIHA, called jointly by Unesco and the Governments of Peru and Brazil, met at Iquitos, Peru, between April 30 and May 10. The conference agreed on a convention establishing the Institute, which will come into force on acceptance by five of the founding nations. Pending the initiation of the Institute, an Interim Commission was set up with its headquarters at Manaos, Brazil.

The following nations were represented at the Conference : Bolivia, Brazil, Colombia, Ecuador, France, Holland, Italy, Peru, United States of America, and Venezuela. Switzerland and the United Kingdom sent observers, as did the Inter-American Institute of Agricultural Science, the International Bureau of Education, the International Council of Scientific Unions, the International Study Conference and the Pan-American Union.

The Final Act was signed *ad referendum* by Bolivia, Brazil, Colombia, Ecuador, Holland, Italy, Peru and Venezuela, and by France without reservation. For the first year of the

[1] Details of these and where they can be obtained can be had from the Secretary, 23 Belgrave Square, London, S.W. 1.

Institute's activities a budget of $306,200 was established. Monetary contributions of signatory states have been set by the Financial Protocol adopted, as follows :—

States	$
Bolivia	9,000
Brazil	150,000
Colombia	40,000
Ecuador	5,000
France	15,000
Holland	5,000
Peru	40,000
Venezuela	25,000

The countries which met in Peru authorised the newly created Institute to receive contributions of equipment and material, rather than monetary contributions, from France and Italy. In addition they approved the proposal that equipment and material be accepted from the United Kingdom if it were offered.

The First Session of the Interim Commission, which was held at Manaos, Brazil, following the Iquitos Conference, made recommendations for activities of the Unesco Hylean Amazon Project during the remainder of 1948. An agreement was arranged between the Director-General and the Interim Commission covering the following programme for 1948.

(a) *General Surveys*

A Community Studies Survey in the lower Amazon and an Associate Institutes and Bibliographies Survey were completed. The latter Survey covered available published and manuscript knowledge on the Hylean Amazon region and also technical bodies and institutes carrying out work related to the future programme of the IIHA. A third planning survey on Administrative and Fiscal Procedures was also made, guided by the resolutions and recommendations contained in the Final Acts of Iquitos and of Manaos.

(b) *Rio Huallaga Survey*

The Director-General organised a team of specialists for a Survey of the Rio Huallaga Valley of Peru. The team, consisting of 6 senior specialists and 10 assistants, entered the valley early in July 1948, for a period of about three months. The Government of Peru actively participated in this survey by bearing a part of the expenses of the team and by extending various facilities.

(c) *Secretariat of the Interim Commission*

Upon the recommendation of the Interim Commission, the Director-General appointed Mr. E. J. H. Corner as Executive Secretary of the Interim Commission, and agreed to utilise a portion of the Budget of the Unesco Hylean Amazon Project for the expenses of the Secretariat of the Interim Commission during 1948. Expenses of the Commission after 1948 are being borne by the signatory countries of the Financial Protocol in the Final Act of Iquitos.

D. Protection of Nature and Conservation of Resources

The Director-General was instructed to accept the invitation of the Economic and Social Council to participate in the preparations for the forthcoming United Nations Scientific Conference on the Conservation and Utilisation of Resources (UNSCCUR) scheduled for August 1949 (Res. 6.9.1, 6.9.2, 6.9.3) and is accordingly represented on the Preparatory Committee of this Conference. Furthermore, an UNSCCUR Secretariat Committee was set up by the Director-General early in 1948, and the services of an expert were obtained to study the draft agenda and terms of reference of the Conference with special attention to the educational, scientific and cultural implications of resources conservation.

During 1948 the Unesco Secretariat received many letters from nature protection experts in a number of countries suggesting that a conference be called during the year for the definite establishment of an international union for the protection of nature, which was provisionally set up at Brunnen, Switzerland, in June–July 1947. Meanwhile, the French Government had taken steps in April to convene such a conference at Fontainebleau from September 30 to October 7, 1948. Unesco associated itself with the French Government in the issuing of invitations and drafted the working papers for the Conference. Moreover, in view of the Director-General's proposal to convene jointly with the International Union for the Protection of Nature (IUPN) a Technical Conference on the Protection of Nature, in the same locality and at the same time as the United Nations Scientific Conference on the Conservation and Utilisation of Resources (UNSCCUR), the Secretariat organised at Fontaine-

bleau a European and African Technical Symposium, for the purpose of studying, in preparation for the 1949 Conference, certain regional problems. The Symposium discussions resulted in a number of resolutions, geared to the proposed Unesco-IUPN Technical Conference, which were adopted at the Final Plenary Meeting of the First Session of the General Conference of the new International Union for the Protection of Nature. The Union also, on the recommendation of the Technical Symposium Committee, designated at Fontainebleau five specialised commissions to study technical problems and work with the Unesco Secretariat in the preparation of the 1949 Technical Conference. A provisional programme for this latter Conference was also drafted at Fontainebleau.

On November 4, 1948, a contract between Unesco and the IUPN was concluded in Paris. This agreement assigns to the Union the main scientific preparation of the 1949 Technical Conference, leaving to Unesco the administrative and material preparation.

It should be noted here that a resolution was adopted at the Inter-American Conference on the Conservation of Renewable Natural Resources (September 1948, Denver, U.S.A.) recommending that the Pan-American Union set up a committee to co-operate with Unesco in plans for the projected Technical Conference.

The International Union for the Protection of Nature, as well as Unesco, appointed representatives to attend the Seventh Pacific Science Congress in Auckland and Christchurch, New Zealand, in February 1949, for an important section on nature conservation and protection problems as they affect the Pacific and Asiatic area.

VII. OTHER UNESCO ACTIVITIES DIRECTLY PERTAINING TO THE NATURAL SCIENCES

A. Book Coupon Scheme

After careful preparation the Unesco Book Coupon Scheme was brought into operation on December 6, 1948, for an experimental period of one year (Res. 2.3.2.2). The scheme, which was devised to overcome foreign exchange difficulties, enables institutions and individuals to buy educational, scientific and cultural books, periodicals and photocopies from 'hard' currency countries, while making payment in their own national currency. It amounts, in effect, to the introduction of an international medium of exchange, with Unesco supplying the necessary 'hard' currency. Booksellers who accept these book coupons for payment will be repaid by Unesco in their respective national currencies.

Coupons of a total $100,000 have been allocated for purchase by China, Czechoslovakia, France, India, Poland and the United Kingdom, and are already on sale through national distributing bodies in Czechoslovakia, France, India, Poland and the United Kingdom.[1] Coupons may be used for the purchase of publications from any of these countries, and in addition from the United States of America. Additional coupons of a total value of $44,126 have been donated by Unesco as part of the allocations made under its Emergency Reconstruction Fund to Austria, China, Czechoslovakia, Greece, Hungary, Italy, Indonesia, Iran, the Philippines and Poland for free distribution in these countries.

B. Fellowships

Unesco's Department of Exchange of Persons is developing an active centre of information on all types of international educational interchange, especially opportunities for international study financed by Governments, public and private agencies, and individuals (Res. 2.1).

Unesco fellowship and travel grants (Res. 2.1.2.5) are open to mature persons such as research workers, technicians, professors, officials, teachers, artists, writers or experts in the mass media. In the administration of fellowships, it is the policy of Unesco to utilise existing agencies wherever possible. The Secretariat's main work is to correspond with beneficiary States in the selection of candidates, to develop plans of study and observation for successful candidates and to correspond with host countries concerning the reception of fellows and the implementation and supervision of their schedules of study.

During 1948 the following fellowships were awarded in the Natural Sciences :—

Country		*Fellowships provided by*	
Austria	3	Unesco-Reconstruction [2]	1
		Canada-Unesco	1
		American Chemical Society	1

[1] Book coupons can be brought from Book Tokens, Ltd., 28 Little Russell Street, London, W.C. 1.
[2] Science and Social Development Fellowship.

Country		*Fellowships provided by*	
Belgium	1	Canada-Unesco	1
China	10	Unesco-Reconstruction [1]	1
		Mathematical Comp. Machines	2
		Canada-Unesco	1
		American Chemical Society	1
		French Government	3
		Belgian Government	1
		Netherlands Government	1
Czechoslovakia	4	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
		American Chemical Society	2
Denmark	2	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
Greece	3	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
		American Chemical Society	1
Hungary	4	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
		American Chemical Society	1
		Norwegian Government	1
India	3	Mathematical Comp. Machines	2
		Netherlands Government	1
Italy	3	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
		American Chemical Society	1
Malta	1	Canada-Unesco	1
Netherlands	3	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
		French Government	1
Norway	2	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
Philippines	2	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
Poland	8	Unesco-Reconstruction [1]	1
		Canada-Unesco	1
		American-Chemical Society	2
		Belgian Government	1
		French Government	1
		Norwegian Government	2

C. Science in General Education

The Director-General was instructed to invite Member States to submit to Unesco statements on the rôle of science in general education in their communities (Res. 3.15). As a first step, the Director-General asked the International Bureau of Education, an inter-governmental organisation, to undertake an enquiry into 'The Introduction to Natural Sciences in the Primary School.' The results of this enquiry will be published in 1949.

D. Social Sciences

The General Conference requested that a source-book be prepared which would describe the studies already under way on tensions arising from technological improvements and the resulting shifts of population (Res. 5.1.1.5). This work was to be initiated only after ascertaining the intentions of the Economic and Social Council in this matter. The Population Commission of ECOSOC is investigating the possibility of calling a World Population Conference at some future date. A Unesco observer participated in the May meeting of the Commission. Meanwhile the Unesco Secretariat has consulted population experts in France and the United Kingdom, and a specialist has prepared a memorandum on the cultural assimilation of immigrants. On the technological side, an expert as prepared a memorandum on the effects of education on the occupational structure of countries.

[1] Science and Social Development Fellowship.

E. Visual and Auditory Materials

The draft of a convention to facilitate the international circulation of visual and auditory materials of an educational, scientific and cultural character has been circulated to Member States and to other states in accordance with General Conference instructions (Res. 2.2.2.2). With the draft were circulated certain amendments proposed by the United States Government. Comments on the draft Convention have, so far, been received from fourteen governments, from the United Nations Department of Public Information and from the Food and Agriculture Organisation.

APPENDIX

List of Documents Prepared by the Department of National Sciences in 1948

(The prefix Unesco/ has been omitted from all the reference numbers. The full reference for the first document, for example, is Unesco/NS/46.)

Field Science Co-operation Offices :

NS/46. Interim Report on the Work of the Field Science Co-operation Offices.
NS/LACDOS/1. Conference of Scientific Experts of Latin America 6–10 Sept. 1948. General information.
NS/LACDOS/2. Provisional Agenda.
NS/LACDOS/3. Projet de règlement intérieur.
NS/LACDOS/4. Acta Final.

Pure Sciences :

NS/HAR/1. General Information on the International Conference on High Altitude Research Stations.
NS/HAR/2. List of the States and Organisations invited to the International Conference on High Altitude Research Stations.
NS/HAR/3. Biological Problems of High Altitude, by Dr. R. Stämpfli.
NS/HAR/4. Cosmic Ray Research at High Altitude, by Dr. J. G. Wilson.
NS/HAR/5. Astronomical Research in High Altitude Stations, report presented by Mr. Jean Roesch.
NS/HAR/6. Memorandum on the Existing High Altitude Research Stations and on the Need for New Stations.
NS/HAR/7. Draft Rules of Procedure, Interlaken, 31 Aug. to 3 Sept. 1948.
NS/HAR/8. Provisional Agenda do.
NS/HAR/9. Provisional Calendar do.
NS/HAR/11. Report of the Committee on Physical and Astronomical Problems in High Altitudes, Dr. J. G. Wilson and Dr. J. Roesch.
NS/HAR/12. Report of the Committee on Biological Problems in High Altitudes, by Dr. R. Stämpfli.
NS/64. Report from the ICSU and its Constituent Organisations on their Activities for which Unesco has allocated Grants-in-aid in 1948.
NS/65. ICSU Statutes.

Medical Sciences :

NS/MSO/1 & Add. Organising Committee of the Permanent Bureau for Co-ordination of International Congresses of Medical Sciences, 12–13 April, 1948.
NS/MSO/2. Exposé by Dr. I. M. Zhukova, 12–13 April, 1948.
NS/MSO/3. List of Congresses.
NS/MSO/4. Declaration of the Representative of the Secretariat of the Temporary Commission of WHO.

Scientific Literature :

NS/56. Working Paper for Expert Committee on Scientific Abstracting, 7–8–9 April, 1948.
NS/57. Provisional Agenda for Expert Committee on Scientific Abstracting, 7–8–9 April, 1948.
NS/58. Bibliography on Abstracting of Scientific Periodicals.
NS/60. Interim Co-ordinating Committee on Medical and Biological Abstracting, 5–6 April, 1948.
NS/61. Interim Co-ordinating Committee Report, by Dr. I. M. Zhukova.
NS/62. Report on Methods of Abstracting.
NS/63. Copyright Problems raised by the question of ' Abstracts.'
NS/SA.MB/1. Conference on Co-ordination of Abstracting Services for Medical Sciences—Preliminary Considerations concerning Co-operation in Scientific Abstracting through an International Clearing House.

Scientific Reconstruction :

NS/47–Rec./3. Proposals for Unesco 1948 Scientific Reconstruction Programme.

Scientific Apparatus Information Service :

NS/45. SAIB Scientific Apparatus Information Bureau.

Social Implications of Science :

NS/SIS/1. Discussion Subject for 1949 : Food and People.

International Institute of the Hylean Amazon :

NS/IIHA/1. General Information on the Conference for the Establishment of the International Institute of the Hylean Amazon.
NS/IIHA/2. Draft Convention of the International Institute of the Hylean Amazon.
NS/IIHA/3. Draft Arrangement for the Interim Commission of the International Institute of the Hylean Amazon.
NS/IIHA/4. The Conference for the Establishment of the International Institute of the Hylean Amazon, List of Governments and International Organisations.
NS/IIHA/5. Provisional Rules of Procedure.
NS/IIHA/6. Some Considerations concerning Financial Questions.
NS/IIHA/7. Provisional Programme on Activities of Unesco Hylean Amazon Project during 1948.
NS/IIHA/8. Provisional Agenda.
NS/IIHA/9. Provisional Calendar.
NS/IIHA/10. Final Act of the Conference for the Establishment of the International Institute of Hylean Amazon.
NS/IIHA/11. Proposed Utilisation of Funds for the Unesco Hylean Amazon Project during the Remainder of 1948.
NS/IIHA/12. Report on the Work of Unesco during 1948 in establishing the International Institute of Hylean Amazon.
NS/IIHA/13. Report on the Progress on the Hylean Amazon Project of Unesco 1947–48 in South America.
NS/IIHA/14. A Social Survey of an Amazon Community with Recommendations for Future Research, by Charles Wagley.
NS/IIHA/15. Summary Report on Geography of the Rio Huallaga Valley, by Edwin B. Doran, jun.
NS/IIHA/15A. Report on Geography of the Rio Huallaga Valley, Peru, by Edwin B. Doran, jun.
NS/IIHA/16. Final Act of the First Session of the Interim Commission.
NS/IIHA/17. Expedition to the River Huallaga, Peru ; Report on Botanical Research in the Valley of the Huallaga, by Ramon Ferreyra.
NS/IIHA/18. Summary Report on Ethnological Survey of the Rio Huallaga Valley, by Anibal Buitron.
NS/IIHA/18A. Ethnological Survey of the Rio Huallaga Valley, by Anibal Buitron.
NS/IIHA/19. Report on the Exploration of the River Huallaga, Peru, by C. Bolivar.
NS/IIHA/20. The Hylean Amazon : A Challenge to Man, by F. J. Malina.

Protection of Nature and Conservation of Resources :

NS/UIPN/1. Conference for the Establishment of the International Union for the Protection of Nature, Fontainebleau, 30 Sept.–7 Oct. 1948—General Information.
NS/UIPN/2. Analysis of the draft Constitution of the International Union for the Protection of Nature adopted at Brunnen 1947, Modifications suggested by Unesco Secretariat.
NS/UIPN/3. Draft Rules of Procedure.
NS/UIPN/5a. List of Governments invited to the Fontainebleau Conference by the French Government jointly with Unesco.
NS/UIPN/5b. List of international and national non-Governmental Organisations invited to the Fontainebleau Conference by the Provisional International Union for the Protection of Nature.
NS/UIPN/5c. International Organisations notified of the calling of the Fontainebleau Conference.
NS/UIPN/6. Provisional Agenda.
NS/UIPN/7. Suggested Calendar, Fontainebleau, 30 Sept.–7 Oct. 1948.
NS/UIPN/8. European and African Technical Symposium.
NS/UIPN/8. Annexes (ten) : Reports of technical symposia and other reports by Dr. I. Gabrielson, M. René Malbrant, Prof. Sembrat, Prof. Baer, Mr. J. Ramsbottom, Mr. Henry G. Maurice, Mr. J. P. Harroy, Dr. K. W. Dammerman, Prof. Goetel, and Mr. Harold J. Coolidge.
NS/UIPN/9. Unesco and International Nature Protection, by Harold J. Coolidge, jun.
NS/UIPN/10. Report on the Technical Symposium, by Prof. R. Heim.
NS/UIPN/11. Provisional List of Delegates.
NS/UIPN/12. International Union for the Protection of Nature—Constitution.

General :

NS/40. Memorandum on the Policy and Practice of Unesco regarding Grants-in-Aid to International Scientific Organisations.
NS/41. Proposed Grants-in-Aid to International Scientific Organisations, 1948 (Extract from 6EX/4).
NS/48. Final Resolutions : The Programme of Unesco in 1948 (Extract from 2C/129 rev.).

THE ECONOMICS OF STRATEGIC DISPERSAL

BY

PROFESSOR BRINLEY THOMAS

I

THE era of large-scale exports of capital and population from the old world to the new was brought to an end by the First World War. The facts of the international economy had altered and were heralding a change in the relationship between America and Europe. But when the nations turned to the task of rebuilding in 1919–20 the tradition of international migration was still very much alive. The habit of decades had become deeply ingrained in the people of Europe and the war had sharpened the desire of many to go overseas to restart their broken lives in a more promising environment. In the years 1921–4 the number of citizens emigrating from Europe (excluding the British Isles) was on an average nearly three-quarters of what it had been in 1901–05 (775,000 compared with 1,053,000). The United States received 2,345,000 immigrant aliens in 1921–24 compared with 3,957,000 in the peak years 1910–13.

As soon as the 1914–18 war was over the British Government set up the Oversea Settlement Committee to advise on migration to the Empire and to foreign countries. In its 1921 Report this Committee used these words: 'The Empire as it exists to-day was largely built up by the policy of State-aided emigration inaugurated by His Majesty's Government a hundred years ago. That policy has profoundly influenced the world's history during the past half century. It may be hoped that, if it is now found possible for His Majesty's Government, in co-operation with the Governments of the self-governing Dominions, to inaugurate a new policy of a like character, the result will be no less important than it is beneficial.'[1] In reading these words now, we should remember that they were written in the midst of the severe post-war slump of 1921; mass unemployment was beginning to cast its shadow on the minds of the policy-makers. Evidently a dispassionate view of history was not one of the Committee's strong points. If they had glanced at what had been happening to the white population of the Empire in the previous century they would have seen that between 1836 and 1900 Great Britain and Ireland suffered a net loss by migration of 8½ millions whilst the net inflow into the rest of the Empire was a mere 2⅓ millions. On balance the Empire had lost nearly 6 millions of its white population through migration to other parts of the world. Looking back in 1921 at the high figure of 200,000 British emigrants to the Dominions in 1913, the exponents of Empire Settlement persuaded themselves that, if so much could be done when the Government was lukewarm and uninspired, there was no limit to what was possible if the scheme were properly planned. They forgot the connection between the boom in emigration just before the war and the abnormal spurt in British capital exports in those years. An example of the misguided optimism of the early twenties was the declaration of Mr. Amery in 1923, 'If the United States have grown in the last century from 5 millions to 100 millions, there is no reason why, in the coming century, we should not grow up to a population of 200 to 300 millions of white people in the Empire.'[2]

In a haze of wishful imperial sentiment and worry about over-population, the Empire Settlement Act was passed into law in 1922. Under it the United Kingdom Government was to spend a maximum yearly sum of £3 millions to finance, in co-operation with public or private organisations at home or in the Dominions, 'agreed schemes for affording joint assistance to suitable persons in the United Kingdom who intend to settle in any part of His Majesty's oversea Dominions.' What was the reaction of the Dominions to this new policy? With the exception of South Africa, they all participated, but they had reservations about the type of immigrant they wanted to have. For example, the British Oversea Settlement Delegation to Australia in 1924 made the following comment: 'To the permanent settlement of migrants on the land Labour is not opposed. But it is concerned that settlement on the land should be permanent, and that those who come out to Australia to help populate the empty spaces should not turn out in the end to be merely adding to the crowds already concentrated in the capitals. It views with alarm the tendency already manifested by the existing rural population to

[1] 1921, Cmd. 1134, p. 12.

[2] 1923, Imperial Economic Conference (1924, Cmd. 2009, pp. 114–15.)

drift into the city, and is determined to prevent as far as possible any addition to this drift on the part of migrants from overseas.' [1] The Delegation to New Zealand emphasised that land values in that country were so inflated as to make it difficult for young men to take up farming. What was required was 'inexpensive land for the improvement of which a man will doubtless have to expend much labour but from which he will be able to reap a due reward, instead of being obliged to utilise the firstfruits of all profits in paying off a debt or an annual interest which amounts in practice to a perpetual rental.' [2] An obsession with land settlement was characteristic of the attitude of the Dominions to Empire migration throughout the inter-war period.

II

The hopes raised by the Empire Settlement Act were far from being fulfilled. The net amount of emigration from Britain to the Empire fell from 112,624 in 1922 to 62,951 in 1929, and the proportion that had to be assisted rose from 23 per cent. to 68 per cent. During the thirties the stream actually flowed the other way, Britain receiving an *inward* balance of 126,000 migrants from the Dominions—a kind of Empire Settlement in reverse. An attempt was made in 1925 to encourage emigration to Australia by promoting the investment of capital. Under the so-called '£34 millions Agreement,' the United Kingdom Government undertook to contribute about half the interest for ten years on capital raised by the Commonwealth Government and spent by the State Governments on public works. On their side the Commonwealth and State Governments undertook to settle one immigrant for each £75 of capital invested. Between 1925 and 1932 only £7 millions were raised under this agreement ; and a Royal Commission which investigated the complaints of settlers in Victoria was severe in its comments on the culpable official laxity in the recruitment of settlers in the United Kingdom and on the faulty handling of the migrants on arrival. All the schemes did not fare as badly : in fact some were quite successful. But they were an expensive method of stimulating overseas migration.

The Dominions safeguarded their interests by practising a system of 'nominations' whereby assisted passages were granted to persons and families from the United Kingdom who were vouched for by friends and relatives already living in the Dominion, the nominator being responsible for a certain period for finding accommodation and a job for the immigrant. Up to 1931 about half the assisted migrants under the Act were nominees of this kind. The great depression put an end to oversea settlement for several years, and when assisted passages to Australia were reintroduced in 1938 the scheme applied only to nominated persons unless they had at least £300 in capital on arrival. Although Australia had lost over 30,000 people of British origin during the slump, the resumption of immigration was not popular in some of the States of the Commonwealth, as there were still large numbers being borne on relief works.

One would have thought that after the United States had introduced its drastic restrictions in 1924, the European surplus would have been absorbed by the Dominions. But, apart from Canada's brief interlude in the twenties, this did not happen. In short, what did the balance-sheet for the white population of the British Empire reveal for the period 1901 to 1936? There was a net outflow of about 3 million people from Great Britain and Ireland and a net inflow of 2¾ millions into the rest of the Empire. Thus, even in the period which saw the end of America's great absorptive power and the launching of an ambitious policy of peopling the oversea Dominions, the British Commonwealth as a whole actually lost a quarter of a million people to the rest of the world. In the century, 1836–1936, the net loss by migration was 6,160,000. If this had not occurred, the white population of the Empire in 1936 would have been 78,620,000 instead of 72,460,000.

The disappointing results of the Act of 1922 produced a mood of scepticism and heart-searching in England. A Committee of Inquiry reporting in 1932 began to draw attention to the falling rate of fertility and the limit it would set to future supplies of migrants. Reviewing the problem in May, 1938, the Oversea Settlement Board did not seem able to make up its mind whether the economic and demographic difficulties weighed less heavily than the strategic advantages of peopling the Dominions. It expressed doubt about the usefulness of further schemes of land settlement and hinted that the Dominions would do well not to confine their attention to Britain but to look to other sources of assimilable immigrants. Out of all this discussion only one constructive idea emerged, namely, that future migration would depend on the Dominions developing industries which would be complementary to those of the mother country.

Britain's migration policy between the wars was vitiated by unresolved contradictions. Enthusiasts who took their cue from

[1] 1924, Cmd. 2132, p. 92.
[2] 1924, Cmd. 2167, p. 29.

Mr. Amery failed to see that the facts of the contemporary world—the relations between agrarian and industrial countries, the volume and direction of capital movements, the trend of natural increase, developments in social security, the intractable problem of unemployment and the spread of protectionism—were very different from what they had been in 1910–13, the last brief interval when oversea settlement had flourished. The inconsistency between the falling tendency of Britain's net reproduction rate and the loss of people through subsidised emigration was disregarded. Nor was it thought at all queer that the following three policies should go hand in hand—using the taxpayer's money to settle British workers overseas, allowing a considerable influx of Irish labour, and applying the Aliens Order of 1920 and our rigid and secretive Naturalisation Law to make the immigration of skilled foreigners as difficult as possible. Between 1922 and 1931 404,000 British emigrants were assisted to go to other parts of the Commonwealth ; in the period 1926–1936 it is estimated that the net immigration from Eire to Britain was not far short of 78,000 ; under the Aliens Order the number of permits rose from 5,359 in 1925 to 21,319 in 1937.

It is not necessarily unwise for a country to be experiencing emigration and immigration at the same time ; on the contrary such a two-way traffic is often essential in view of the heterogeneous nature of demands for labour. Our pre-war policy was tied to the crude idea that, whatever the circumstances, you could never go wrong by stimulating movement to the Empire and preventing foreigners from coming in. No alien wishing to enter the service of an employer here was allowed to land unless he produced ' a permit in writing for his engagement issued to the employer by the Ministry of Labour.' These permits were granted for a limited period of between one week and twelve months, and often there was a condition that the employer must take steps during this interval to train a British subject for the work in question. With the exception of a few hundred foreign engineers to erect and repair important machinery, there was no recruitment into industry proper : in 1937 three out of every five of the permits granted were for domestic servants. And yet at that very time a detailed analysis of the engineering industry showed that ' acute shortage and long delays were evident in the recruitment of the more skilled operatives, particularly for the tool room and the machine shop. Nor was it possible to supply many of the less skilled workers without moderate lags, especially when low wages or unfavourable conditions of work were offered.' [1] Refugees anxious to flee from Hitler's prison-house were kept at bay by a mountain of red-tape. The then Home Secretary explained that ' he would be quite prepared to admit, under proper safeguards, a very much larger number of refugees from the Continent for training in this country, *provided it was quite certain that they could eventually find a place of permanent settlement elsewhere after training.*' [2]

The economic circumstances of Britain in the late thirties called for a re-examination of the whole foundations of the Empire Settlement policy ; but the power of traditional thinking was still considerable. The Committee on Empire Migration in 1932 had pointed out that there was ' a profound disharmony between the economic needs of Great Britain on the one hand and the Dominions on the other in regard to migration. Now that it might suit us to send large numbers of our people to the Dominions it does not suit the Dominions to receive them. When the time comes when the Dominions will again welcome immigrants, it may not be to our economic interest to supply the need.' [3] The prophecy in this last sentence has now come true, though not in the way anticipated by the writers in 1932. The second World War has transformed the scene and radically altered the whole setting of the problem.

III

The end of the Second World War brought a change in the attitude of the Dominions. Inspired mainly by strategic considerations, they become anxious to attract a considerable flow of immigrants from the United Kingdom. A typical example of the new military thinking was seen in an essay which won the Trench Gascoigne Prize of the Royal United Service Institution in 1946.[4] The subject was : ' How can the lessons learnt from the development of the Services in organisation and technique since 1939 be applied most efficiently to the solution of Imperial Defence Problems ? ' The author points out that the United Kingdom is now vulnerable for three reasons, its geographical nearness to the Continent, the concentration of its people in industrial areas, and the inadequacy of its agricultural resources. ' So inadequate were the preparations for the late war that, had the Germans succeeded in landing only 100,000 men in England in 1941, it is

[1] R. G. D. Allen and Brinley Thomas, ' The Supply of Engineering Labour under Boom Conditions,' *Economic Journal*, June 1939, p. 272.

[2] *The Times*, April 27, 1939. (Author's italics.)

[3] 1932, Cmd. 4075, p. 24.

[4] Trench Gascoigne Prize Essay, 1946, by Squadron-Leader S. L. Swain, R.A.F., *Journal of the Royal United Service Institution*, May 1947, pp. 165–86.

unlikely that they could have been defeated. Considering what was accomplished by the Allies against the prepared defences of Normandy, one can only wonder that the attempt was not made.' [1] The Essay concludes that ' in a long war, possibly requiring initial withdrawals, the military effort could be continued from new bases, even without sea communications, provided the civil power could continue to support it. *As at present disposed, the civil power of the Commonwealth is not able to meet this requirement.* While, therefore, continuing to seek antidotes to the weapons that may be used against us, let us consider the result of dispensing some of Great Britain's millions over the Commonwealth :

(a) The reduced population could be self-supporting in foodstuffs and less dependent on sea communications for raw materials, and the small concentrations of people would present less vital targets for air attack.

(b) The Dominions, reinforced financially, industrially and in essential manpower, would represent increased reserves of civil power and provide for military/civil resistance in depth throughout the Commonwealth.

(c) The local defence capacity of each member would be more able to take the strain of initial aggression and the loss of any one member would no longer prejudice the entire Commonwealth framework.

(d) All members would be in a better position to contribute to a Commonwealth striking force held at readiness for repair reinforcement of any molested area.

Such redisposition of peoples, planned according to the resources of raw materials and the manufacturing needs of the Dominions concerned, could result in the setting-up of three or four almost self-supporting defensive centres, having a combined strength far in excess of that now possessed.' [2]

So far as the layman can see, the strategic argument seems to have logic on its side. The British Commonwealth and Empire represents a considerable aggregation of power, and the experience of two World Wars proves that its capacity for concerted action is far greater than would appear from the loose links that bind it together in peacetime. While political power within this family of nations is being progressively decentralised, it becomes more and more of an anachronism that so much of the economic potential should be located in its most vulnerable corner. A strategy for defence must postulate total war, and so the military planner cannot avoid drawing up schemes having far-reaching economic, political and sociological implications. In the past Britain could feel reasonable safe by spending enough on the upkeep of her navy, without even the trouble of having military conscription. She could prepare for all contingencies without interfering with the freedom of her citizens to live as they wanted to. But by now the revolution in the art of war has robbed our island of the advantage for defence which she used to possess. By herself Britain will in future lack the necessary power of initiative : her safety therefore depends much more than ever before on the combined strength of the group of countries with which she has a special affinity. The imperial strategist argues that the only way in which the combined strength of this group can be increased is by moving a substantial part of the manpower and industries of the centre to the extremities. Logically the conclusion seems inescapable. You cannot produce the necessary deterrent effect on a potential aggressor and expect to leave the shape and course of peace-time life unaffected. It is argued that part of the price of a maximum degree of security in an atomic age must, therefore, be planned migration with all its inevitable economic and social disturbance.

There are broadly two ways in which such a strategic dispersal could be carried out: either by transplanting over a period of years, say, ten million people comprising a cross-section of the whole community, or by large-scale promotion of spontaneous emigration. I shall first assume the latter as the more practicable possibility and examine its probable economic consequences.

IV

There was an actual case of spontaneous mass emigration within this country between the wars. Wales experienced a net loss by migration of 430,000 between 1921 and 1939, equal to one-sixth of her population in 1921. Dr. H. W. Singer calculated the age-composition of the emigrants from the four counties of South Wales between 1921 and 1931 as follows.[3]

Age Groups. (*Both sexes.*)	*Percentage of Total Migrants*
0–14	12·7
15–29	53·4
30–44	21·3
45–59	10·1
60 and over	2·5
	100·0

[1] Trench Gascoigne Prize Essay, 1946, by Squadron-Leader S. L. Swain, R.A.F., *Journal of the Royal United Service Institution*, May 1947, p. 167.

[2] *Ibid.*, p. 179. Italics in the original.

[3] *Pilgrim Trust Unemployment Inquiry*, 1937.

Taking the heart of the depressed area, the Rhondda Urban District, Dr. Singer estimated what the population would have been in 1941, assuming that the emigration of 1921–31 were attributed wholly to the second half of that decade and that the same rate of outflow continued in the ten year period ending in 1941. The age distribution of the emigrants was assumed to be the same as in the census decade 1921–31. The projection showed that by 1941 the structure of the population of the Rhondda Valleys would have become very distorted. If we regard persons between the ages of 15 and 50 as the industrially active group, the position in 1921 was that for every 100 industrially active persons there were 67 inactive because of youth and 25 inactive because of age. By 1941 for every 100 in the active group there would have been 52 inactive because of youth and 61 inactive because of age. Assuming those over 50 had the same standard of maintenance as the active producers, this change would, other things being equal, have entailed a decline in real income a head by nearly 25 per cent.

The depressed areas were a running sore in the body of Britain between the wars. Much of their strength was drained away to the South-East and the Midlands, and the producers left behind found themselves saddled with the maintenance of excessive social capital and the cost of relieving a growing army of paupers. This cumulative downward process with its deadening effect on morale was of course caused by market forces not by an act of policy ; but it serves nevertheless to remind us how mass emigration affects the losing area.

It is clear that emigration tends to add to the weight of older dependants to be carried by a shrinking body of active producers. The social services introduced by the Labour Government are a mortgage on the future wealth-creating energies of this country : for example, it is estimated that the cost of retirement pensions will go up from £238 million in 1948 to £501 million in 1978, and this takes no account of emigration. In view of what Mr. Herbert Morrison has called ' the vast cheques drawn on our future national resources,' what is to happen if we deliberately deplete still further our most precious remaining asset—our supply of young skilled man-power ? These cheques are not likely to be cashed at anywhere near their face value if a good part of the labour needed to deliver the goods is just given away for nothing.

Another disadvantage of emigration is that it will make the economic system more rigid. By reducing the relative number of new entrants to the labour market each year, it will call for more mobility on the part of adult workers already committed to jobs and reluctant to leave them. Movements from one occupation to another in response to new inventions or changes in consumers' tastes take place more smoothly if there is a high proportion of juveniles in the labour supply. No one can deny that the strength of Britain as a member of any defensive bloc depends to a great extent on her capacity to keep her productive system technically up to date, and this implies flexibility in the labour market. There is a real danger that, given mass emigration, the course would be set towards the ossified state.

When men move overseas, there is a tendency for money to go with them. A costly efflux of funds took place, *e.g.*, to South Africa, in 1947–48. A persistent leakage of capital would be very harmful to a country whose major task in the coming years is to increase considerably the supply of its own savings for use at home ; and we must not forget that with this capital would go technicians and managers—from an economy which is already severely handicapped owing to neglect of the art of business management. To-day we are faced with widespread obsolescence due to the negligence of inter-war years as well as the deliberate arrears of normal re-investment forced upon us during the war. Therefore, large sums are to be spent on renewing capital equipment by nationalised industries, semi-public corporations and private firms. But the trouble at the present time is *under-saving*. So powerful was the Keynesian searchlight in throwing into relief the under-investment of the thirties that many people are now blind to the fact that, to quote Keynes, ' when full employment is reached, any attempt to increase investment still further will set up a tendency in money-prices to rise without limit, irrespective of the marginal propensity to consume. . . .' In this state of affairs a community which wants to re-build and extend its capital equipment can do so only by cutting down the fraction of its current resources which it consumes. One cannot have it both ways. There is no widow's cruse to supply the funds for all and sundry.

A programme of strategic dispersal involving emigration of capital and business managers is hardly compatible with a plan which presupposes a higher rate of domestic saving.

The outflow of capital and skill already taking place is a trickle compared with what will happen if the ideas of the defence theorists are put into effect. Let us look at the prospect more closely, on the assumption that the British Government favours mass emigration for strategic reasons. On the one hand, the Government is committed to

raising the level of technical efficiency in industry, both public and private; at the same time, its programme involves building up the community's social capital. Both these imply a higher rate of voluntary or compulsory saving. On the other hand, by bringing about what may be called a secular shift away from profit—through a redistribution of income in favour of wage-earners, it makes it more difficult to secure the required increase in voluntary savings. Then, to make matters worse, the emigration programme will knock another big hole in the supply of capital for use at home, though it will be partially offset by a reduction in the demand for equipment owing to the departure of emigrants. The two parts of this general policy are mutually contradictory.

So far I have said nothing about that other mortgage on Britain's future social product, namely, the debts owed to sterling creditors and the United States. These amount to well over £4,000 million. To pay back what we owe we must provide our creditors with goods or services. The part of our exports earmarked for this purpose cannot, therefore, bring in anything in return. It will take us a long time to settle these accounts, and the instalment in any one year will not be much. For example, the American Loan will be repaid in fifty annual sums beginning on December 31, 1951. But as Britain's welfare is going to depend so much on what her exports will procure for her, her interests will suffer if anything happens to add to the toll levied on her by 'unrequited' exports. It has already been shown that mass emigration will make the active producers a small fraction of the population and therefore the burden of the debt a head will increase. The same argument applies to the cost of maintaining fixed equipment of all kinds. The burden of the national debt a head will rise, and the heavy weight of taxation implied by these charges will tend to swallow up any gains that may come from technical progress. It is strange that some people who are most anxious to rehabilitate the one-time depressed areas of Britain are at the same time advocating a policy which might well turn the whole country into the depressed area of the Commonwealth.

V

At this point it might be objected that the whole argument so far has been based on the assumption that the redistribution of the population of the Commonwealth would take place by encouraging *spontaneous* emigration from the United Kingdom. Why cannot the efflux be arranged in such a way that a cross-section of our people—children and old people as well as those in the prime of life—would settle in the Dominions? Many Australians sympathise with this view. There have been reports that Mr. Calwell, the Australian Minister of Immigration, has a plan by which Australia would receive old people as well as the young and middle-aged, take over a portion of Britain's national debt and build ships to be used exclusively for carrying the migrants.

If settlement in the Dominions were to be organised in this way, it would have to be planned. There have, of course, been examples of highly successful transfers of whole communities. However, the scale of migration contemplated by the defence theorists is very considerable; and we have to ask ourselves whether it could be done without seriously interfering with individual liberties. The planning authorities would have to be empowered to say to some people that they must go and to others that they must stay behind. The ultimate logic of total defence against total war is that it is incompatible with some of the essential freedoms. Ignoring this point, we may admit that a balanced emigration would be much less likely to distort the age structure. The increase in the weight of the old dependants to be carried by active producers might be avoided; but some of the evil consequences already noted would still be felt—for example, the rising overhead cost of fixed equipment and social services, the leakage of capital, rigidity in the labour market and declining productivity. The impact on this country would depend on the scale of the movement, on the particular grades of labour chosen for settlement, and on whether there would be large-scale immigration from Europe at the same time. It is clearly desirable that new industries and processes connected with defence and requiring wide open spaces should be located in the Dominions and there is no reason why 'new towns,' populated partly by British settlers, should not be established overseas. If, however, this planned migration of industries and manpower were of a magnitude consistent with the aims of the military theorists, it would probably leave Britain in such a weakened condition she would be of little use either to the Commonwealth or to Western Union.

VI

Perhaps the most damaging weakness of the new theory of imperial defence is that it is drawn on too small a canvas. Indeed, it is already seriously out of date. Any plan which treats the security of this island as a mere Commonwealth problem is unrealistic: our destiny is bound up with that of a wider group of like-minded nations, of which the United States is the supreme power. It is

extraordinary how vague and casual some of our military theorists are in their references to the rôle of the United States.[1] If the British Commonwealth and Empire were a viable economic group capable of overcoming a potential aggressor without outside help, there would be a *prima facie* case for strategic dispersal. But surely the facts do not warrant such an optimistic assumption.

The days are over when Britain could afford to sit back and rely on being able to organise powerful coalitions on the continent of Europe. The Second World War was not won in that way. It is the United States alone which is now in the position of being able to direct, marshal and sustain the forces of a grand coalition, while Britain and the Commonwealth must necessarily play a subsidiary, though by no means negligible, rôle in such a design. We must accept the grim fact that our island is in danger of sudden disaster so long as Western Europe is too weak to ward off attack. We are in the front line, and our security depends on the weight of military power that can be quickly deployed in Europe if Russia chooses to commit aggression. It is estimated that in 1950 the population of Soviet Russia, plus that of Europe at present under her control, will be about 340 millions, whereas the Western European countries will have about 280 millions, of which Britain constitutes just over one-sixth. Relative numbers are, of course, not a decisive criterion ; one should make allowance for the superior quality and technical skill of the Western peoples. On the other hand, as democracies they are not subject to one directing authority and they need time before they can bring their combined strength into play.

Man-power is an important criterion of military power ; and I propose to consider the estimated number of men aged 15–64 who will be east and west of the iron curtain in 1950 and 1970. The figures, which are based on the work of a Committee of the League of Nations appointed to study demographic trends in Europe, are set out in the following Table.

Estimated Number of Men aged 15–64 *in European Countries.*[2]
(*Thousands.*)

Countries West of Iron Curtain.	1950.	1970.
U.K. and Ireland	17,200	16,600
Western Europe	41,100	40,100
Scandinavia	4,700	4,600
Southern Europe	30,000	33,900
Total	93,000	95,200
Countries East of Iron Curtain.		
U.S.S.R.	60,200	84,100
Eastern Europe	46,700	51,900
	106,900	136,000

Given the existing location of the iron curtain, there is no marked disparity between the number of men of working age in the Russian and Western areas at the present time. But we know from bitter experience that the loss of a crucial battle in the 'cold war' may change the balance of power overnight. To survive, the western countries must be strong enough to put up a massive defence at short notice ; they must be able to hold the fort until the overwhelming resources of the United States and the Dominions can be mobilised to the full. Any appearance of weakness or vacillation invites aggression. Clearly the rôle of Britain is to contribute as much strength as possible to Western Union, particularly in the short run, and to provide effective leadership in this sector : this is not the time to cast our bread indiscriminately on imperial waters. As to the long run, the man-power balance will move heavily against Western Union in the next twenty years ; by 1970 there will be 136 million men aged 15–64 in Russia's sphere of influence compared with 107 million in Western Europe ; but if we can overcome the immediate threat, there will be an opportunity for the fertilising stream of American aid to convert this manpower deficit into a decisive surplus of power.

The relevant problem is not so much to define the rôle of Britain within the context of imperial defence but to discover the most economic use of the resources of Britain and the Empire within the wider orbit of the Western Democracies taken as a whole. On this latter plane of reasoning it is by no means obvious that a wise defence policy requires a mass exodus from this country.

(*Based on a paper read to the British Association on September* 13, 1948.)

[1] See the comments of Mr. Bernard Brodie, in his penetrating article, 'How Strong is Britain?' in *Foreign Affairs*, April 1948.

[2] Based on F. W. Notestein and others, *The Future Population of Europe and the Soviet Union* (League of Nations, Geneva, 1944), Appendix lv.

The composition of the areas is as follows :

Western Europe—Austria, Belgium, France, Germany (British, American and French Zones), Netherlands, Switzerland ;

Scandinavia—Denmark, Norway, Sweden ;

Southern Europe—Italy, Portugal, Spain, Greece.

MOVEMENTS OF ATOMS IN CRYSTALS

BY

MRS. KATHLEEN LONSDALE, F.R.S.

ALMOST everyone except the scientist is clear as to the difference between a solid, a liquid and a gas. A solid retains its shape and size except when subjected to considerable force. A liquid takes the shape of the vessel into which it is poured but remains of the same volume as before pouring, while a gas will expand, or can be forced without too much difficulty to contract, into a container of nearly any shape or size. But it is not quite as simple as that. There are many substances, such as putty, paper, rubber and wool, which can hardly be called rigid and which nevertheless do not conform to the usual idea of a liquid. There are the glasses and certain of the plastics, which soften gradually on heating and become liquid, although there is no exact point at which the change can be said to take place. Other kinds of solids, however, have a definite melting-point, a temperature at which they suddenly lose their rigidity and become fluid, and at which many of their other physical properties such as density, electrical conductivity and so on, also show an abrupt change. The change from ice to water at 0° C. or 32° F. is one which is most familiar to us. Yet ice in the form of glaciers can flow almost like a liquid. What does this signify? What happens to the atoms or molecules when a substance changes its state, when it ceases to be a solid and becomes liquid or gas? Or when, still in the solid state, it undergoes deformation or begins to 'creep'?

Regular arrangements of atoms will scatter X-rays in such a way as to give regular diffraction patterns, which can be recorded photographically or detected in other ways. Such X-ray diffraction patterns are given by all crystalline solids and indeed by all solids which have a definite melting-point, even though they may not always show the regular geometrical forms which we normally associate with the word 'crystal.' The atoms in such solids are associated with a regular three-dimensional pattern, and the melting-point is the temperature at which the regularity breaks down and the arrangement becomes disordered. The solid has become a liquid. Why does the regularity break down at a particular temperature? And why is there no such abrupt breakdown in the case of glass? The point is that although the atoms of a crystalline solid are *associated* with a pattern, they are in fact moving all the time. All atoms are moving all the time, except at the absolute zero of temperature. In the solid state they are vibrating about fixed positions, the vibration amplitudes becoming bigger as the temperature rises. The atoms behave rather as if they were connected by elastic springs which are stiff at low temperatures, but which become more elastic as the temperature increases. In the liquid state the atoms or molecules still exert considerable force on each other so that they still adhere together, but they can change places and move relatively easily. The ease of movement is measured by the physical property known as viscosity. When the liquid becomes a gas the atoms or molecules move independently and at comparatively big distances from each other. The atoms of a liquid or a gas will scatter X-rays but they give only one or two diffuse rings, from which the average distance apart of atoms forming molecular or temporary groups can be calculated. There is no *pattern* in liquids or gases. Glasses give the same kind of diffuse ring pattern, showing again that there is no regular arrangement of the mean atomic positions. A glass is really a liquid with very high viscosity. The movements of the atoms are not large enough to enable exchange of positions to take place, at least not until the temperature is sufficiently high for the glass to begin to soften. Glasses are formed on sudden cooling of a liquid in which there are no local centres, no so-called 'seeds' where crystallisation can take place. This abrupt cooling retains the disorderly arrangement of the liquid phase.

We are now in a position to state more clearly what is happening in a crystalline body. The atoms or molecules forming a crystal are arranged in what, at absolute zero of temperature, is a regular or nearly regular pattern. As the temperature rises, the crystal expands, not necessarily equally in all directions. This means that the atoms or molecules which form the crystal pattern each occupy more space at higher temperatures. It does *not* mean that the atoms themselves increase in actual size; the atomic system of nucleus and electrons is much too strong to be particularly affected by a change of temperature. What it does mean is that the atomic vibrations are becoming more and more

violent as the solid becomes hotter. Occasionally an atom may even break away from its normal position in the pattern and migrate through the solid ; that is particularly easy if there are occasional holes, that is, vacant sites, in the pattern. This kind of diffusion in the solid state can take place in some metals and can be detected by making a few of the atoms radio-active. Some different kinds of metals, when placed in close contact, will diffuse into each other ; metal atoms evaporated *in vacuo* on to the surface of galena crystals will sometimes diffuse right inside. When a solid is made up of small crystallites, thermal vibration will allow atoms from the surface of one crystallite to migrate to another, so that some grains will grow at the expense of others. This happens in metals during annealing and also in glaciers. The liquid-like flow of ice is due to the deformation under applied stress of some crystals, and the growth of these crystals at the expense of others less favourably oriented ; and all these atomic rearrangements are activated by the thermal movements of the atoms, on which the external applied force (the weight of ice pushing from above) imposes a preferential direction.

Sometimes it is possible to alter the crystalline pattern of a metal completely by cold-working a single crystal in directions along which the atomic vibrations are particularly large. Barrett has done this with lithium crystals at low temperatures. They can be transformed from a body-centred cubic to face-centred cubic structure in this way. But it is not generally necessary to cold-work crystals in order to produce such transformations. Quite often they occur with change of temperature alone, or with change of pressure, or even with time, as in the case of age-hardening or the devitrification of glass. And in every case they are the consequence of movements brought about by thermal vibrations of the atoms or of changes in those vibrations due to some change in external circumstances.

Now the atomic vibrations must, of course, affect, and be affected by, the forces between neighbouring atoms, and they are therefore related to the elastic properties of the crystal as a whole ; which are also, for single crystals, dependent on the forces between neighbouring atoms. In the case of those metals which have relatively simple structural arrangements of atoms, the nature of the atomic vibrations can actually be calculated if the elastic properties of the single metallic crystals are known. It will readily be understood that a complete knowledge of the atomic vibrations, of their frequencies, amplitudes, polarisations and preferred directions, would give invaluable information about the nature and strength of the forces between the atoms, information which is of interest to the physicist and to the chemist alike, not to mention the engineer. But there are other atomic movements not related to the elastic properties of the crystal. When the atoms are joined into molecules, not only will the molecules vibrate individually, but the atoms in the molecule will vibrate so that the shape of the molecule changes. The molecule may also oscillate or even, at higher temperatures, it may begin to rotate, perhaps about one particular axis, or perhaps in all directions, so that it simulates the symmetry of a cylinder or of a sphere. If the molecular rotation sets in suddenly, it will correspond to a temperature transformation of the crystalline structure to a form of higher symmetry.

All these atomic movements can be studied by means of X-rays. Changes of crystalline symmetry or the growth or deformation of crystals can be observed by goniometrical or microscopic measurements ; but X-ray methods tell us what is happening to the crystalline pattern on the atomic and molecular scale. The first stage of an X-ray examination, that is, measurement of the geometry and intensity of the sharp X-ray diffraction patterns given by the crystals, tells us what is the pattern that represents the average arrangement of the atoms or molecules in time and space, at the temperature of the experiment. The next stage is to make measurements of the differing intensities of X-ray diffraction in particular directions, at different temperatures. This gives the mean values of the vibration amplitudes at these temperatures ; the more violently the atoms vibrate, the less efficiently they combine to give a sharp diffraction pattern. The intensity decreases as the temperature rises, according to the law

$$I_T = I_0 \exp\left(-\frac{4\pi^2}{3d^2}\cdot\overline{u^2}\right)$$

where d is the distance between successive planes of atoms in the direction considered, and $\overline{u^2}$ is the mean square amplitude of atomic vibration. By this means, James, Waller and Firth showed, over 20 years ago, that in rock salt, NaCl, the sodium atoms were vibrating somewhat more violently than the chlorine atoms, at all temperatures. In general, it is true that different atoms in a single compound will have different vibration amplitudes. In rock salt at room temperatures the average amplitudes of vibration of the sodium atoms is 0·24 Å and of the chlorine atoms 0·22 Å, as compared with the distance between neighbouring sodium and chlorine atoms, which is 2·8 Å. This does not seem much, but the frequency of vibration is 10^{13}

per second, so that any one atom actually travels about 50,000 miles in 24 hours, even though it is seldom more than one 1,000-millionth of an inch from its own doorstep.

In some crystals, for example, in those of the alkali metals lithium, sodium, potassium, the average vibration amplitudes are more than twice as large as in the ionic crystals. These metals are soft, easy to shear or to compress. In other crystals which are hard and difficult to deform, such as diamond and tungsten, the atomic vibrations are very much smaller. So far, however, we have considered only average values, and we have been talking mainly about crystals of high symmetry. We know that in crystals such as graphite, which has a layer structure, the layers vibrate much more strongly relative to each other than do the atoms within the layers, which are much more strongly bound. This vibration of the layers relative to each other dies down at low temperatures, which explains the fact that charcoal (which is essentially rather impure graphite in a fine state of division) has to be cooled to the temperature of liquid air to become a really efficient absorber of gases. On the other hand, in chain structures such as those of the natural vegetable and protein fibres, or long-chain fatty acids, the chains can wriggle and oscillate or alter their mutual distances, but the atoms in the chains do not move very much along the length of the chain. It would be rather curious if they did. It would mean that blades of grass, besides moving from side to side, would expand and contract, that hair would stretch or shrink as easily as it can now be bent.

It is possible also to investigate the anisotropy of the thermal vibrations by means of X-rays, but for this purpose the crystal is photographed in a stationary condition using a narrow monochromatic beam, or a beam containing a high proportion of one X-ray wave-length only. We find that the thermal vibrations of the atoms are responsible for a diffuse yet, in some cases, quite elaborate background pattern on these photographs. Where the structure is simple, it is possible to predict in detail exactly what this pattern will be, from a knowledge of the elastic properties of the single crystal. It is also possible to predict in general outline what is to be expected from a layer or chain structure, and to use the photographs to decide the orientation of molecules in unknown structures. But at present we must admit that we have a wealth of experimental data here that we cannot yet explain.

I have mentioned that the thermal vibrations have a frequency of 10^{13} per second. This seems very large, but the frequency of X-rays is much larger ; it is 10^{18} per second. To the X-rays, therefore, the atoms in the crystal at any given instant appear to be quite stationary, but the pattern they form is a distorted one. During the time of exposure of an X-ray photograph, what is actually recorded is the sum total of the diffraction from billions of differently distorted patterns. It is only in relatively simple cases that it is possible to work back from the recorded pattern to the vibration spectrum which causes it. In other cases it is only possible to guess what the vibrations are and to calculate what diffraction effects they would cause. There is a big field for research here and as yet it is, relatively speaking, untouched.

Perhaps I may conclude by mentioning neutron diffraction by crystals, and the effect of the atomic movements in this case. There are many analogies between X-ray and neutron scattering by crystals, but there are two main differences. The first is that X-rays are scattered by the electrons, neutrons by the nuclei. X-rays therefore show what is the pattern assumed by the atoms considered chiefly as electronic clouds, neutrons show the pin-point pattern of the atomic centres. The second difference is that whereas the X-ray frequency is 10^{18} per second, the frequency corresponding to thermal neutrons is 10^{13} per second, just the same as that of the vibrating atoms. So far only the question of the intensity variation for neutron scattering at different temperatures has been considered in detail, and here the same formula applies as in the X-ray case, but the *diffuse* scattering of neutrons caused by thermal movements of the atoms will be of rather a different character from that of X-rays.

(*Paper read to the Physics Section at the Annual Meeting of the British Association*, 1948.)

MOBILITY IN THE LOCATION OF INDUSTRY IN GREAT BRITAIN

BY

MR. WILFRED SMITH

IT is common knowledge that industries differ in the closeness of their fixation to materials, that, for example, blast furnaces must be in proximity to coal or ore but that engineering may be widely dispersed. But, while this is common knowledge when expressed in general terms, little work has been done until recently in constructing a hierarchy of industries, in arranging them into sets, those which are fixed by their materials and those which are free to be located elsewhere.

My first work on this problem was *The Distribution of Population and the Location of Industry on Merseyside*, published in 1942. Professor Sargant Florence has since worked also in the same field, particularly in his book, *Investment, Location and Size of Plant*, published early in 1948. His concern with degree of heaviness of industry and my concern with degree of fixation to materials are not identical, as will appear. In the work of 1942 I confined attention to the type of industry located on Merseyside, but I have since worked through the whole range of British factory industry and this paper embodies the conclusions to date. The Fifth Census of Production provided most of my evidence with the aid of which it is possible to devise tests in order to classify industries into groups in degree of fixation to materials.

The first test is that of cost of materials as a percentage of gross output. This is not the most satisfactory test but it is easy to calculate for *all* industries and it serves as a useful introduction to the problems involved. If the percentage cost of materials be high and if cost of materials bulks large in cost of production, it would seem reasonable to infer that the industry is likely to be located close to its materials. If it is low, it would seem reasonable to infer that the industry is free to be located elsewhere than close to its materials. In blast furnace work the cost of materials in 1935 was 79 per cent. of the value of the gross output and blast furnaces, with very few exceptions, are located close to coal or ore. But in steel works and rolling mills it was 62 per cent., in mechanical engineering 41 per cent. and in foundry work 39 per cent. Steel works and rolling mills are, in fact, less completely tied to coal and ore, while engineering shops and foundries are widely dispersed, foundries being found in every town and engineering shops in most. The facts of location thus coincide with the evidence of this test of percentage cost of materials. Many other examples could be given. On this test, baking is more mobile than grain milling, the making of sweets is more mobile than sugar refining, the making of soap and paints is more mobile than seed crushing. Within a given sequence of industries, using the same material but in a more and more manufactured form, the locational tie to the original material becomes more and more tenuous and the industry making the finished product ready for consumption becomes free to be located elsewhere, in close contact with its market if that be held to be desirable on other grounds.

But this test has marked deficiencies as a result of differing economic structure, according to whether the industry be organised vertically or horizontally and according to whether the industry be in a handicraft or factory phase. In 1935 cost of materials was 67 per cent. of gross output in worsted spinning, but 47 per cent. in woollen manufacture, which includes both woollen spinning and manufacture. Both industries employ wool, but in West Yorkshire, which dominates the country's total, they differ in their economic structure. In the woollen industry all processes, except dyeing, are integrated on the same site, but in the worsted industry disintegration is common, spinners being separate from weavers. In an integrated mill work on the material comprises both spinning and weaving, but in a spinning mill or weaving shed the work is on one of these alone. The amount of the material is the same, but there is a greater aggregate of labour costs in the integrated mills and the cost-of-materials percentage, therefore, is lower. Fortunately, the Census report submits for the larger industrial groups an estimate of production free from duplication. For the woollen and worsted trades as a whole cost of materials was approximately 47–48 per cent. Such adjustments for duplication improve the efficiency of the cost-of-materials test very considerably. The difference between handicraft and factory manufacture is also significant. It is the rule for a handicraft industry to have a lower

materials percentage cost than a factory industry. Thus retail bespoke tailoring has a lower figure than wholesale factory tailoring. There has been an increase in the cost-of-materials percentage in motor car manufacture with the adoption of flow methods of assembly and the reduction in labour costs in consequence. The test possesses other deficiencies as well.

The second test is the weight of material employed in the manufacturing process. If the weight be substantial, it is reasonable to expect the industry to be tied to the source of its materials. The ratio employed is the weight of material per operative. As returned to the Fifth Census, without adjustment according to size of sample or as a result of duplication, this was in 1935 over 1,700 tons per operative in blast furnaces, nearly 150 tons in steel works and rolling mills, 29 tons in foundries and 9 tons in mechanical engineering shops. There are the same sort of differences between grain milling and baking, sugar refining and sugar confectionery, seed crushing and soap and paints. There is a much wider dispersion between the lowest and the highest values on this second test than on the first and those industries with a high weight-of-materials index stand out very prominently from the rest. With a wider dispersion the index may be expected to have a greater sensitivity. There is a bunching of industries with a low weight-of-materials index and many have a lower status with regard to fixation at materials on the second than on the first test. Prominent among these are the textile trades. They have a higher status on the first test because their materials are relatively valuable in proportion to their weight. This in itself is a further criticism of the validity of the first test.

This second test, however, has two practical defects. In the first place, it is impossible for many industries to calculate an index from the weight particulars given in the Census tables. This is a serious defect in the construction of a test designed to apply to the whole range of industry. The defect may be limited, though not corrected, by adjusting the weight of materials according to the size of the sample. In the second place, it is probable that some materials used in large quantities are unrecorded in the Census tables both in weight and in value, when these materials are not purchased. This is frequently the case with clay in the brick and fire-clay trades, for the clay pits are on the site of the brick-works and are usually owned by the same firm. The vast quantities of water used by textile finishers and paper-makers are probably also unrecorded except where purchased from town mains.

It may be concluded that neither of these tests, while valuable, can be regarded as automatic indices in their present imperfect form. The weight test is capable of refinement if weights could be specified for a wider range of materials in the manufacturers' returns and it is almost certainly capable of greater ultimate refinement than the first test, which is complicated by the complex industrial structure of the country and the varying ratio between weight and value of materials. The second test may be regarded as more reliable than the first.

The third test is in many ways correlative with the second. This is the value of product per ton. Most industries employing a large bulk of material make a product relatively low in value. Blast-furnace work, brick making, grain milling, sugar refining all spring to the mind as examples. Conversely, industries using a small bulk of material frequently make an article high in value in proportion to weight. Tailoring, cutlery, tobacco are obvious examples. There is a greater agreement between classification on those two tests, weight of materials per operative and value of product per ton, than between any other of the classifications considered. The most prominent divergencies are themselves significant. Those with a higher rank in weight of materials include metal smelting and rolling, seed crushing, butter, cheese and condensed milk manufacture, in all of which there is a large loss of weight in respect of the main product in the course of manufacture. Those with a higher rank in value of product per ton include baking, tin box and cardboard box making, whose products take up more space than the materials from which they are made. As Weber has pointed out, the weight-losing industries are pulled to the source of materials. It might be added that conversely the space-gaining tend to be located at the point of consumption. This third test is subject to the same practical defects as the second. It can be calculated for only a proportion of the output of many industries.

A fourth test of a heavy industry is the proportion of males in the total operative force. It may also be indirectly a test of fixation to materials, but only if a large proportion of males is a result of the heavy weights handled. There is a high proportion of males in many industries which handle only small aggregate weights of materials. Moreover, we are now familiar with rapidly changing sex proportions in industry under the conditions of a war-time economy and there is clearly no permanence in the percentage of males. My conclusion is that, while the proportion of males may give useful additional evidence, it is secondary to weight of materials and is likely to be unreliable as a primary test.

Professor Sargant Florence proposes the addition of a fifth test, that of horse-power per operative employed. This is obviously a valid test for his purpose, the measuring of the relative heaviness of an industry, and he finds it to be second in value to weight of materials. It is to be expected that industries using bulky materials will have a large quantity of machine equipment to handle them. Nevertheless, the classification according to horse-power and the classification according to weight of material do not everywhere coincide. The textile industries, for example, have a higher status in horse-power than in weight of materials, for their materials are low in weight but are subjected to many successive mechanical processes. The same is true of engineering shops. Conversely, baking, brick and fire-clay, china and earthenware all have a lower rank in horse-power than in weight of materials, for they are oven or kiln industries requiring only a limited amount of engine drive. These discrepancies make the horse-power test less efficient than that of weight of materials in testing fixation to material supplies.

Each of the tests considered has grave defects. Some of these are inherent in the nature of the test, but some are remediable and can be corrected by more detailed information. It is not yet possible to construct a completely sensitive index in which each industry falls into place and which covers the entire range of British factory manufacture. But, although they do not provide a key to unlock all mysteries, it is submitted that these tests do permit a reasonable approach to this particular facet of the problem of the location of industry.

(*Substance of a paper read to the Section of Geography at the Annual Meeting of the Association,* 1948.)

SHORTAGE OF SCIENTIFIC AND TECHNICAL BOOKS

In 1948 the acute shortage of scientific and technical books (which still continues) was a subject of frequent discussion among men of science, teachers, students and many others concerned with education. It was also a subject of lively correspondence in national newspapers. It was discussed informally by members of the British Association during the annual meeting at Brighton with the result that the Sections of Engineering and Physiology recommended that the Council should investigate the causes of the shortage.

When considering this recommendation on November 5, 1948, the Council were informed that the Parliamentary and Scientific Committee had already made representations to the Lord President of the Council on the shortage of scientific and technical books and periodicals, and that this Committee, not being satisfied with the Lord President's answer, proposed to make further representations concerning paper, machinery and labour. The Council decided that independent action on this matter would not be appropriate, but that a useful purpose might be served by enquiring into the possibility of reducing delay in the production of certain kinds of scientific and technical books (especially ' post-graduate ' memoirs) by adopting the continental practice of binding in paper ; and they agreed to appoint a Committee to consider this question and report.

The Committee thus appointed consisted of Sir Richard Southwell, F.R.S. (Chairman), Mr. Ritchie Calder, C.B.E., Wing-Commander T. R. Cave-Browne-Cave, C.B.E., Professor H. Hartridge, F.R.S., and Professor E. H. Neville. The Committee presented a report on June 3, 1949, which was approved by the Council who authorised its publication in the hope that it might assist in disposing of some popular misconceptions. The following is the text of the report.

1. Admittedly the crux of the problem referred to the Committee is in binding, and much publicity has been given to the suggestion, amounting almost to an accusation, that the use of paper bindings, common on the Continent for books of all kinds and known to the trade as wrappers, offered an easy solution which was withheld from the authors and buyers of English books only by the conservatism and obstinacy of the publishing houses—though why reputable firms which presumably like to publish books should need outside pressure to adopt an easy solution was not clearly explained. The fallacies which render the suggestion plausible have been exposed in the press, and in particular were the subject of a careful and authoritative communication from Sir Stanley Unwin

which appeared in *The Times Literary Supplement* on the day after our appointment. Nevertheless, meeting after a good deal of informal enquiry and correspondence we agreed that, since the publisher is an interested party, we as a body representing users' interests could usefully present a considered report on the publishers' argument against wrappers, and investigate the one other alternative to the traditional cloth binding which we could envisage, namely, sets of uncut and unstitched sheets, 'banded,' to use the technical term, like a packet of envelopes, simply to prevent loss in handling.

2. It should be emphasised at the outset that the 'case,' as the cloth binding is properly called, is not itself expensive in either material or man-power; it is made, and sometimes affixed, by machinery, and it seldom adds as much as 6*d.* to the manufacturing cost of the finished book (Sir Stanley Unwin, *loc. cit.*). Nor has there been a serious shortage of material for cases. The hold-up that could be eased by the substitution of paper for 'cloth' at the final stage of production is a figment of the imagination. There is no immediate prospect of supplies of cloth becoming inadequate, and unless this occurs the only reason for suppression of 'casing' is the labour of operations which *precede* that process.

3. In forming a picture of the labour which might be saved by 'wrappering' we are indebted to a publisher for the following lists :—

Casing	Wrappering
* Folding	* Folding
Gathering	Gathering
End-papering	End-papering
* Sewing	* Sewing
Cutting	Glueing
First glueing	Drawing on paper
Rounding and Backing	Cutting
Lining	Pressing
Applying mull	
Casing-in	
Pressing	

The asterisked processes of folding and sewing are usually effected by machine; the penultimate casing-in is sometimes a machine operation also.

Comparison suggests that paper binding can at best save relatively little time. Moreover, unless more harm is to be done than good, only a part of an edition can be wrappered. Most English booksellers prefer to deal only with cloth-bound books, librarians will not issue uncased volumes, and subsequent binding of single volumes by the purchaser is appallingly uneconomic. The complication of an edition prepared in two forms and sold at two prices offsets even the slight possible gain. Nor is it irrelevant that we are concerned with a short-term policy to meet an emergency, not with a long-term policy to reorganise the industry; there are no data on which the initial demand for wrappered volumes can be estimated, but bad guesses will not be swamped in years of stabilised sales. We see no escape from the emphatic conclusion of printers and publishers, that wrappering is not to be undertaken as a short-term policy.

4. We conclude with a consideration of banded sets of sheets. For these Mr. Roberts has given us a simple list of processes :—

Banding
* Folding
Gathering
Pressing
Banding

The saving in labour is substantial, and there is no significant loss on unsold stock to be taken into account, since a banded set can be cased at any time. In fact some English publishers with branches in America already export sheets thus, to be sewn and cased in transatlantic binderies.

If such a packet would be valuable to the impatient reader, it would seem to be desirable to make it available to him. It is hardly to be expected that booksellers would want to handle these packets, or that publishers would improvise arrangements for the dispatch of single sets except on clear evidence of a strong demand. The American demand, as we have said, results in the bulk export of banded sets, and a *small* demand from individual buyers in this country alone would be better met by re-import of volumes from America than by the establishment of a new form of retailing here. We thought it therefore of importance to elicit continental reactions to the project of supplying banded sheets, especially as urgent pleas for English books have come from war-damaged continental universities. A letter of enquiry was addressed to a Dutch scientist whose plea, in a review, for paper-bound copies had been among the arguments for one of the motions leading to our appointment as a Committee. His reply gave us little encouragement, for not only did he expect Dutch booksellers to dislike handling banded sets, but he also thought that individual purchasers though content with paper binding would not be ready to dispense with binding altogether.

In short, while the reader complains that he cannot have just what he wants, the publisher is right in saying that it is useless to offer him anything less. Only the author, forced to remain inarticulate, has a grievance beyond his own power to alleviate.

THE ADMINISTRATION OF LARGE SCALE ENTERPRISES[1]

BY

MR. J. C. PICTON

THE word 'enterprises' suggests all those forms of economic activity which are directed immediately or eventually towards the satisfaction of the wants of consumers. It is not proposed to elaborate this into a descriptive list of the various forms of organisation which are apparent in a modern economic society, but it is important to note that it includes public enterprise in all its manifestations. This is worthy of emphasis because it has become apparent that the nationalised industries are experiencing some considerable difficulty in the solution of their administrative problems.

As to 'administration,' the assumption can be made that it begins at the point where the determination of policy has been concluded. It is assumed that the broad objectives of the enterprise are known, and the problem of administration then lies in the creation and the operation of the mechanism whereby those objectives are to be attained.

The term 'large scale' suggests that at a certain scale of operations, the problems of administration present themselves in a special form. It would be unwise for the present purposes to attempt any form of statistical assessment, but it is still possible to define in general terms the critical point of change. If administration is accepted as the operation of a mechanism, then it presupposes an operator, or operators, in control of the mechanism. The alternative of one operator or more provides a hint, because as soon as the mechanism becomes too great for control by one person, it becomes necessary to share and delegate the function of control. It is fair to assume therefore that the character of the administrative problem changes at the point where the enterprise can no longer be controlled by one man and it will be convenient to conclude, somewhat surprisingly perhaps, that all enterprises larger than the 'one man business' are large scale enterprises for the present purpose.

The nature of the change in the character of the administrative problem will be better appreciated if some of the features of the one man business are noted. The single controller, administrator, or briefly 'the boss,' embodies in himself all authority and responsibility, and the size of the mechanism he controls is such that he commands full and up-to-date knowledge of its operations. There are limitations of knowledge, naturally, and they reflect themselves in the efficiency of operations. A type of business man is certainly often met who combines in himself a detailed knowledge of the technical processes of his factory, a flair for commercial affairs and a capacity for leadership, but on the other hand, many small manufacturers lack, for example, the sound knowledge of costs which is essential for proper guidance in determining price policy.

One of the great advantages of the one man business is the rapidity of executive decisions; there is no delay to allow for consultations with colleagues, for reference to rules or appeals to higher authority; the boss embodies in himself the knowledge, authority and responsibility required to give an immediate decision. It may, possibly by reason of inadequate knowledge, be the wrong decision, but in the conduct of business affairs the harm done by a quick wrong decision may often be less than that caused by the correct decision given too late. A variation in the terms of a quotation is required; the small man gives his answer immediately during an interview with his customer; the representative of a large organisation is often at a disadvantage because he cannot decide on his own responsibility—he must refer it to a director, or 'put it up to his works.' Or in the field of industrial relations, the employees have a direct and immediate approach to the boss who gives an instant decision. In large concerns, many disputes have been allowed to develop to the point of a stoppage of work, not because of an unsatisfactory reply from the management, but because of the absence of any kind of reaction in a reasonable time.

Some of the attributes of the boss attach to the chief executive of large scale organisations, notably in the effect his personality has upon those with whom he comes into contact, or ought to come into contact. The wise managing director will not remain aloof from his employees nor from his customers; they like to retain the maximum of personal contact, and their assessment of the management as a whole is largely, and often very accurately, based upon the behaviour of the

[1] Substance of a paper read to the Economics Section at the Annual Meeting of the Association, 1946.

managing director. It would probably surprise many a chief executive to know how much the ' tone ' of his business is set by his own behaviour. Arrogance, snobbishness, intolerance and dictatorial behaviour in high places are noted and copied in the ranks, and what would seem to be a large impersonal organisation in fact reproduced in the conduct of its staff the personal characteristics of its chief.

In general, however, the problem of administration is different for the managing director of a large concern from that of the boss of the one man business. Whereas the latter combines in himself knowledge, authority and responsibility, in the large organisation there must be a division of functions. The task of implementing the policy of the board of directors, although in principle laid upon the managing director as the board's executive instrument, is in fact delegated to subordinates who report the results of their activities to the managing director for subsequent submission to the board. The task is therefore subdivided and the separate results of performance are re-assembled by the managing director for his periodic justification of stewardship.

The problem of administration in the large scale enterprise lies in this subdivision and delegation of duties and their subsequent reassembly. The acquisition of knowledge for example involves the systematic recording of data relating to processes, costs, sales and accounts. These records must be readily available and their salient features immediately apparent not only to their compiler but also to those unfamiliar with their composition. The process of the assimilation or digestion of data is one of great significance in a large organisation ; so often systems of recording are devised, often at great cost by specialists hired for the purpose, providing to a meticulous degree a mass of information not understood by the recording clerks and not used, even if understood, by their superiors. Here is one aspect of the special kind of problem introduced because the scale of operation is so large that tasks must be shared : the proper appreciation and use of data collected by others.

Even if the recorded data be well assimilated, there still remains in the large organisation the problem of its dissemination to interested executives. Cost data must be available to technical managers ; accounting information is required by sales managers ; production plans must be transmitted to the buyer. Moreover the size of the organisation may make it necessary to devise special measures for general publicity to employees about the activities of the concern : house magazines have been introduced partly for this reason. The rank and file, particularly when involved only in a minute portion of a highly subdivided process, can be quite ignorant of the final nature of the product they are helping to make. During the war, a marked improvement in the morale of workmen followed exhibitions devised so as to illustrate the relation of their tasks to the equipment used by the fighting services. Equally, senior members of staff in highly departmentalised concerns can often be unaware of new developments in the organisation, and unless they are kept informed, they can suffer the embarrassment of being given information about their own business by members of other companies.

It is this difficulty of transmitting information which often gives rise to the criticism of ' red tape.' For example, it would appear reasonable for a manufacturing department to nominate one of its staff to co-ordinate its demands upon the maintenance department. This co-ordinator must obviously be informed when orders are given which are within his sphere, but a newcomer to the department might object to the submission to the co-ordinator of a copy of his order to the maintenance department if he did not realise that this element of ' red tape ' originated in the necessity for canalising requirements in order to facilitate control and, in this case, avoid overloading the maintenance department. The process of multiplying forms can certainly be carried to extremes, but those practical busy business men who so often criticise public departments for ' red tape ' should reflect upon the principle involved and they might well examine their own consciences and their own office systems before casting the first stone of criticism.

There still remains the domain of action even after proper attention to knowledge, and it is here that the delegation of responsibility and authority must be considered. It demands a nice balance between the clear definition of duties and spheres of authority on the one hand, and on the other hand the insistence upon co-ordination in the performance of those duties. For example, the research laboratory and the manufacturing department must be clear upon the kind of task that each is required to perform ; but there must also be secured a measure of interchange of opinion and experience to the benefit of both. It is vital that there should be no trespass of authority without explanation : if it is within the sphere of the Transport Officer to control the company's cars, the Assistant Secretary should not be instructed to license and insure a car without informing both officers of the special reasons for this breach of routine.

It is in the large organisation that is encountered that instrument of action or inaction called the committee. Its necessity arises fundamentally from the subdivision of the administrative task. Beyond a certain point it becomes impossible for a single executive to take action because his knowledge and authority are insufficient for him to arrive at and implement his decision. It becomes necessary for him to consult colleagues who contribute their knowledge and authority to the solution of the problem if the committee is simply advisory, or to the implementing of the decision if the committee has executive authority.

In this sphere again there may be excess. In principle, the committee is a super-individual; it re-assembles in one entity the functions divided among many individuals. It may degenerate however into a merely deliberative and dilatory body acting as no more than a convenient pigeon hole if not a waste-paper basket.

A recent development is the use of the specialist separate from the organisation itself. The advantage lies in the more varied knowledge and experience which is brought to bear by the consultant than can be assumed to be available inside the organisation. This would be of particular value in determining, as an administrative decision, whether to employ a publicity agency or a firm of consultant production engineers. An alternative to the introduction of the outside consultant would be to relieve of their daily burdens two or three specialist executives, allow them opportunities for acquiring such data as they might require outside the organisation and then apply their detailed internal knowledge to the solution of the problem. The money spent in consultant's fees can be spent (usually only a part would be required) in the appointment of staff to undertake the routine tasks of the executives whilst they are engaged in the special investigation. If it had no other advantage this procedure would provide that whatever scheme was introduced would be operated eventually by its initiators, and not left with a complex voluminous book of instructions as the parting gift of the outside expert, who can always claim subsequently that any faults which may arise are due to the application rather than the conception of his scheme.

It is implied in this conception of the subdividing and subsequent reassembly of functions that some kind of system must be adopted, recorded and made known in precise terms. Duties and status must be defined, rules and regulations must be promulgated, records must be compiled. It is at this stage that one should embark upon a discussion of various principles of delegation and certainly produce at least one administrative chart. The value of such an excursion is however somewhat doubtful owing to the assumptions that have to be made before any conclusions may be drawn. The value of such investigations is greatest when they are related to particular circumstances, and even then reservations are permissible. One notable chart, in its first edition, omitted the functions of one of the managing director's three chief assistants, the omission having survived several weeks of preliminary discussion of the chart. However, even assuming a full and correct chart, it merely reflects a passing phase in the organisation. It is certainly useful as an historical document, but few organisations are so little subject to change that their administrative chart remains accurate for any sensible length of time.

The importance lies not in the system itself, but in the human factors involved in its operation. The personalities of the officers must in any case have considerable bearing upon the determination of functions, certainly in the higher ranks. But in addition the system as a whole is intended as a means of directing the operations of human beings. The problem of administration is not confined to the organisation of the work of the administrative staff; it is concerned also with the factory workers, with all the employees. In many ways, the relations between the management and the factory workpeople present to-day the greatest single problem in administration. Unfortunately it is in dealing with this very problem that the increase in the scale of operations aggravates most the difficulties of administration, for it is the very increase in size which makes it impossible to maintain that personal contact between the management and the employees which eases friction and facilitates co-operation. The individual worker has no direct access to the higher authorities, his sense of self-importance is affronted and he feels a lack of real participation in the work of the concern.

There are two trends in administration which can be discerned in the attempts to re-establish in large scale organisations the close relations between employer and employed, which characterise the one man business. In the first place, the employee is given access to the management through the medium of a special executive designated Personnel Manager, Labour Officer or the like. The functions of that executive include that of providing for the individual employee the opportunity of presenting a problem in a personal way, of meeting the impersonal 'Management' in the form of a human being. This satisfaction of direct personal access to the employing authority follows of

course only if the Personnel Manager is of sufficiently high status for the employee to feel that really authoritative decisions are being given. Often the benefit of the introduction of a personnel department is lost because insufficient authority is given to it and its status is obviously inadequate in the eyes of the employees with whom it has to deal.

Secondly there is the beginning of a movement towards participation in management. This is as yet in its very early stages and of course represents an advance upon the position in the one man business where the boss is by his very nature probably the last man to subscribe to any theory of participation by his workers in the control of his business. The formal relation is now to be found in the Joint Consultative Committees which have become an essential part of the administrative mechanism of most large concerns. Their sphere of activity is strictly limited, but even in those cases where they are confined to a purely advisory capacity they serve a useful purpose in providing the means for exchange of views between management and employees and for the dissemination of information about changes in policy and new developments. The measure of their success lies in the degree to which the workers feel that they are really being consulted on matters of common concern and that their views are thought worthy of consideration.

The Joint Consultative Committee is an attractive field for study, but for the present two aspects only must be the limit of comment. The first is that its value is not always appreciated by the mass of employees. Indeed it is not infrequent that the lack of interest of the majority may be an embarrassment to the management. Nevertheless in spite of a possible apathy on the part of the majority, there will always be a minority well aware of the significance of the Joint Consultative Committee, meticulous in their attention to the detail of its work, and anxious that there should be no deviations from constitutional procedure. It is that minority which exhibits the most obvious benefits of Joint Consultative Committees : the mere opportunity for self-expression and the realisation that his personal contributions to discussion are valued frequently transforms an obstructive into a constructive personality.

The second comment is a plea for the black-coated worker. So often the Joint Consultative Committee is a vehicle for consultation between the higher management and factory operatives only, whilst the clerks and the lesser managerial staff have no representation. This segregation of ' the office ' and ' the works ' is most unhappy and the Joint Consultative Committee provides an admirable opportunity not only for breaking down the barriers between the two, but also for removing a widespread and often justifiable impression on the part of junior staff that they are ignored by the management.

It becomes more and more apparent as we examine the problem of administration that it has ceased to be a consideration of impersonal factors. The establishment of a mere framework of functions, status and authority is not enough in itself ; it is the spirit which is infused into the administrative system which is important, for the object of the system is to establish a set of relations between human beings so as to ensure their whole-hearted co-operation in the achievement of common objectives. There must be created a sense of common purpose and effort by the higher management, junior staff and factory workers, and only to the extent that that sense of unity is achieved will the administration succeed in releasing the full reserves of energy which lie in industry.

The real problem of administration to-day does not lie in the determination of abstract lines of authority and control. This has its place certainly ; there must be a clear and well-defined relationship between departments and between officers, but whatever system is established as the administrative mechanism, it must be such as to satisfy the sense of responsibility of the persons who will give life to it. Administration is not merely a means to an end, not merely a mechanism for the attainment of the objectives of the concern as laid down in a board policy. The nature of the mechanism carries a social purpose in itself, in that it is operated by human beings, and the problem is to provide them with the maximum fulfilment of their personalities in the process of attaining the objectives of the concern. That is the new factor which can be discerned in administration to-day : the attempt to combine the private objectives of the concern with its social responsibilities. It employs men and women, not merely ' hands,' and those men and women will make their best contribution only when they are accepted as fully responsible participating members of the concern.

RURAL HOUSE TYPES.

BY

PROF. R. A. CORDINGLEY AND M. MARCEL MAGET

FOR the Annual Meeting of the Association in 1948 Section H (Archaeology and Anthropology) planned to arrange a symposium on rural house types in Western Europe and speakers were invited from Sweden, France and Eire as well as from England. In the event, Prof. Erixon (Sweden) and Captain O'Danachair (Eire) were unable to be present, but M. Marcel Maget (Director of Ethnography at the Musée National des Arts et Traditions Populaires in Paris) and Prof. R. A. Cordingley reported on investigations of rural dwelling-house types in France and in England and there follows the substance of their papers.

A SCHEME FOR THE INVESTIGATION OF ENGLISH RURAL DWELLING TYPES

by

Prof. R. A. Cordingley

THE ultimate objective of the investigation is to determine the modes and zones of activity or influence of local manifestations of English folk life. Since, as is axiomatic, buildings afford the most direct and potent evidence of human cultures, and among them, no type is more expressive than the domestic, the immediate aim adopted was that of resolving the evidence that surviving dwellings can afford towards the more distant end. In establishing the method of enquiry, it was soon seen that nothing less than a comprehensive record of all sufficiently-surviving dwellings would securely establish the facts.

The year 1840 was adopted as a terminal date, or, should any house of an earlier time bear recognisable evidence of the impact of the Industrial Revolution, it was to be ignored. The term 'rural' equally required some definition: modern industrial towns were to be examined only at the fringes where the buildings were openly spaced and not contiguous; other towns of up to a present population of 5,000 to 6,000 could be surveyed as a whole. 'Metropolitan' county towns occasioned the only real difficulty but in these, experience showed that the 'urban' heart could fairly readily be partitioned and excluded.

Dwellings can vary in type in the several principal particulars of size (social grade), spatial disposition, materials of structure, and mode of use of the latter. Of these, two are more important than the rest,—namely size and materials of wall structure. Walling materials not only limit and constrain the inner dispositions into certain broad classes, but determine too, quite narrowly, the constructive forms, features and methods of decoration.

Size, and materials of structure, can be assessed from outside a dwelling, and better from outside than in. Spatial dispositions are betrayed externally too, and equally, most of the constructive forms, features and decorations. Hence it was seen to be feasible to make a searching enquiry by external review alone, a conclusion which brought the whole enterprise of comprehensive record within the sphere of 'practical politics.'

The greatest importance attaches to the definition of size-types upon a fixed basis, since these, most often, represent social classes. The index accepted was that of the chimney-flue and stack, cross-checked by number of rooms (estimated from the windows), number of stories and the mass disposition of parts. Four types were established; cottage, small house, large house, great house. The last type was not to be investigated in detail, since it is beyond the intimate, folk-class, scale.

Materials of wall structure fall into only five main groups; timber, stone, brick, flint and cobble (which occasion similar techniques), and earth. Every house is constructed essentially of one or more of these materials.

The above distinctions between dwelling types, if recorded suitably could serve as a means of establishing a network of differing regional practices, but with security only as regards one particular point of time. Additionally, a means was required of determining phases of evolutionary development. Yet, in this country, the materials used for wall-structure themselves may indicate period broadly. With rare exceptions, the smaller surviving dwellings rarely ante-date the fifteenth century, and between this and 1840 is no great space of time. Even so, it is partitioned by evolutionary changes in the use of walling materials. 'Half-timber' is the earliest in use, for the smaller dwellings, and progressively increasing scarcity of oak

allows the recognition of perhaps four successive stages. (The hey-day of the minor half-timber houses was the later sixteenth century.) Timber supplies mostly gave out or became excessively scant round about 1700, and the once almost universal half-timber structures gave way to a miscellany of local, sometimes highly-local and most indifferent alternatives. Some of the expedient practices were quite short-lived and expired before the end of the eighteenth century; others were protracted into the nineteenth. These 'splinter' styles—as they may be called, for convenience—included that direct successor of the half-timber, the 'frame' house, variously sheathed with boarding, plaster, tiles or that remarkable departure from the last, the 'mechanic' tile, simulating mortared brickwork, of which there were many kinds including the peculiar black, vitreous-faced type, as seen in the Royal Crescent at Brighton. Other expedients were rammed earth, local stones won almost from the site, the flint or the cobble. Eventually, all gave way to the renascent brick, though not in every case within the period here adopted as 'historical.' In similar way, there was a significant succession of roofing materials, indicative, if not narrowly of date, at least of evolutionary succession. Thus materials alone, of wall and roof, carry implications of period, quite apart from the changing manner of their use. Building practices, of course, in the several materials, evolved as time progressed and particular types can be related to particular times.

The foregoing considerations led to the conclusion that it would be quite practicable to construct a form of questionnaire, in which systematically listed enquiries would be framed, calculated to extract all the significant answers as to the regional affinity and the time-phase of each house. The questionnaire form of enquiry was indeed the only type which would allow systematic assessment and direct comparisons or contrasts between house and house. In the matter of time-phase, buildings bearing date panels would put securely into place whole groups of houses bearing similar characteristics. Incidentally, dated houses have proved in experience so far to be more numerous in most localities than might have been expected. The proportion in certain instances and in fairly extensive areas has proved as high as ten per cent.

Consequently, questionnaire 'charts' were prepared, one chart for each prime walling material; stone, brick, timber, etc. Each of the charts was subdivided into columns, headed respectively, 'walls,' 'windows,' 'roofs,' 'roofing materials,' and the like, or designed to extract special information relative to the situation of a house, its possible liaison with other dwellings or places of work and 'special features' of decoration and design. Under each column heading, every alternative of practice or kind ascertainable was listed in a short descriptive statement and numbered by a system which, whilst allowing for the insertion of any further alternative expedients not previously encountered, permitted a record to be expressed numerically, in a four-figure number. By such means, the entire circumstances of a house might be very fully described in a single line of four-figure numbers, and take no more than five minutes in the doing. This record was to be card-indexed, house for house, each illustrated by an identification photograph and accompanied by location particulars.

Omitting mention of certain intermediate processes of review of the record data, it may be said that when mapped, the house locations can be made to fall immediately into a regional mesh for any chosen phase of time. The successive phases can themselves be mapped. For each regional phase-type, the method of record allows the ready identification of specific 'ideal' instances, which can then be scrutinised in detail inside and out, in all particulars. Similarly, by mapping, the distribution of particular usages, decorative or otherwise, can be traced, and the nodes located.

Work on these lines has been in desultory progress for some five years. Latterly, progress has been made at a much faster pace. Some 2,000 square miles has been completed, including one compact area of over 1,000 square miles in N. Lancashire and portions of neighbouring counties. Several quite distinctive regions emerge in the latter, characterised by two types of stone walling practice, by brick, and sea-shore and river cobbles. Scarcely a trace of half-timber survives, although it was once customary in the western part of the area. The consequential oddity is that whilst the surviving dwellings in the fertile lowland tracts are comparatively recent, none earlier than about 1700, rather more than half the known dates in the neighbouring, relatively unproductive uplands fall in the previous century.

An Investigation of Rural Architecture in France

by

M. Marcel Maget

Monsieur Maget introduced his paper with a reference to the extreme diversity of house types in France. The country has many distinctive regions ranging from coastal settlements to the highest village in Europe (Saint-

Véran at 2,000 metres) ; it has three different maritime climates and a variety of continental climates ; it has been inhabited both in the country and in industrial regions by people of diverse origin, language and culture ; and agricultural buildings range from those on highly mechanised farms to chalets in Savoy which still provide shelter for man and beast under one roof. In view of all this diversity of environment and culture it is hardly surprising that the domestic dwellings of France are widely varied in form and conception. M. Maget then described the methods and results of a study of this rich variety of house types.

L'étude en fut inaugurée par Vidal de la Blache et poursuivie par les disciples du maître, membres de l'école française de géographie. L'un d'eux, le regretté Demangeon y consacra une grande part de son œuvre et c'est à lui qu'est dû le premier essai de classification systématique des maisons rurales. En 1937, il organisait, dans le cadre de l'Exposition internationale de Paris, une exposition sur ce sujet, en liaison avec le Musée National des arts et traditions populaires. La même année, ce musée [1] entreprenait un mission d'étude en Sologne, suivie d'autres en Alsace et en Provence, au cours desquelles fut élaborée une méthode d'enquête architecturale en fonction du genre de vie.[2]

Sur ces principes furent établies les instructions données, de 1942 à 1946, à une équipe d'une cinquantaine d'architectes chargés par le Ministère de la Reconstruction, avec le concours scientifique du Musée, d'une enquête sur l'habitat rural en France. Chacun eut à prospecter alors une région équivalent à la surface d'un à deux départements français. De 1946 à 1948, ce chantier fut transformé en centre de formation d'architectes ruraux (Ministère du Travail) qui continua l'œuvre entreprise en particulier en Alsace restée inaccessible pendant l'occupation.

De 1942 à 1948, les méthodes de travail se perfectionnèrent au contact des réalités, surtout depuis que le but principal passait plus expressément de la recherche scientifique à la formation professionnelle. Mais le schéma général demeura sensiblement le même :

Travail préliminaire

Initiation aux méthodes d'investigation totale du milieu, principalement sous ses aspects géographique, technique, économique et social. Etude des instruments d'enquête (plan de monographie—technique de relevé).

Choix d'une région à prospecter (de préférence celle avec laquelle l'enquêteur avait des affinités). Etude de la documentation existant sur cette région. Etablissement d'un plan de travail. Organisation pratique de la mission (contacts par correspondance).

Travail sur le terrain

Prospection préalable de l'ensemble de la région, confrontation avec la documentation. Choix d'exploitations agricoles devant faire l'objet de monographie.[3]

Etude monographique des exploitations choisies portant sur :—

(i) milieu (Caractères géographiques et culturels de la région et de la commune) ; (ii) généralités sur l'exploitation : nature, cheptel, personnel, situation, terres exploitées (nombre, surface, nature) ; (iii) morphologie; (iv) matériaux et techniques ; (v) historique ; (vi) analyse critique ; (vii) opinions (des habitants, des techniciens locaux . . .) ; (viii) comparaison avec specimens voisins.

Etablissement d'un rapport général sur l'habitat de la région étudiée.[4]

Ainsi ont été réunies environ quinze cents monographies pour l'ensemble du territoire métropolitain. Non encore publiées mais déposées au Musée, elles constituent un ensemble documentaire d'une très grande richesse au sein duquel le moindre sondage permet de concevoir ce que pourra apporter un dépouillement systématique. Mises à la disposition des chercheurs scientifiques aussi bien que des techniciens de l'architecture elles ont déjà fourni aux uns comme aux autres un précieux moyen de connaître la réalité concrète et de formuler ou de vérifier des hypothèses. Ne pouvant donner ici une revue complète des résultats obtenus, nous nous bornerons à quelques exemples portant les uns sur des éléments (cheminées, charpente), les autres sur des ensembles.

Problème de répartition d'éléments architecturaux

1. *Cas du foyer.* Le dispositif le plus fréquent en France est l'âtre sur mur pignon. La cheminée sur mur gouttereau est

[1] Dirigé par M. G. H. Rivière.

[2] L'enquête architecturale était menée par G. S. Pison appelé depuis aux fonctions d'architecte en chef du Ministère à la Reconstruction et à l'Urbanisme.

[3] Cette prospection correspond, quant au but et aux méthodes générales, à l'enquête menée par le Professeur R. A. Cordingley, mais sans en avoir la rigueur statistique.

[4] Le travail sur le terrain était effectué en liaison avec les personnes et organismes s'intéressant à ces questions : professeur de géographie de l'Université du ressort, directeur des sciences agricoles, ingénieur du génie rural, etc. . . . La description de la méthode et des exemples des résultats obtenus ont été donnés dans la revue *Techniques et Architecture*, Paris, 1947, nº 1–2.

A partir de 1946, les enquêteurs avaient en outre à étudier un projet d'aménagement moderne des localités étudiées.

relativement rare. Deux autres dispositifs attirent l'attention : (i) la cheminée centrale, soit sans appui (dite ' cheminée sarrasine ') que l'on trouve encore en Bresse et dans l'Ain, soit abritée par une cloison l'entourant parfois au point de former une sorte de local central (' tué ' du Doubs) ; (ii) la cheminée constituée par un massif de maçonnerie à trois côtés bâti au centre ou quelquefois sur un côté des habitations en pans de bois de Haute Normandie. Le premier fait penser au dispositif de la ' Diele ' de Basse Saxe, tandis que le second présente une remarquable analogie avex la cheminée de la ' förkökhus ' suédoise.[1]

2. *Cas de la charpente.* En gros, deux systèmes se distinguent dans la façon de construire un toit. Dans l'un, des pannes (purlins), reposent sur les murs porteurs et murs de refend ; la maçonnerie domine dans cette construction qui semble caractéristique de la civilisation méditerranéenne. Dans le second, le toit repose sur des fermes qui peuvent être placées seulement aux points intermédiaires entre les murs pignons ou même constituer l'ossature de ces derniers, cas de la construction en pans de bois (half-timbered work).

(a) *Charpente sur panne et charpente sur chevrons (spars)*

Ces fermes présentent une grande variété de combinaisons parmi lesquelles les travaux allemands avaient, avant guerre, souligné une différence fondamentale entre le toit sur panne faîtière (Pfettendach) et le toit sur chevrons (Sparrendach). Ce dernier, le plus répandu dans les régions de langue germanique, semblait être ignoré en France et a fortiori dans les pays méditerranéens. Or, l'enquête a révélé l'existence de toit sur chevrons non seulement en Alsace, mais également dans d'autres régions telles que le Massif Central (Aveyron, Cantal, Haute-Loire, et même Ardèche) et la Bretagne.

(b) ' *Cruck-construction* ' *en Bretagne*

Dans son ouvrage sur la maison galloise, J. C. Peate décrit comme caractéristique la ' cruck-construction ' dans laquelle le ferme est constituée par deux arbalétriers (principal rafters) courbes, assemblés à leur extrémité supérieure de façon à former une fourche sur laquelle repose la panne faîtière (ridge piece). L'enquête apporte des exemples de charpentes identiques en Bretagne, dans le Finistère, les Côtes-du-Nord, le Morbihan et la Brière. Dans l'état actuel de l'enquête, elle n'apparaît pas ailleurs en France où domine la ferme à poinçon (kingpost).

On peut considérer ces régions comme des zones de persistance de traits autrefois beaucoup plus répandus, sinon généraux, qui auraient été remplacés progressivement par des traits nouveaux. Il s'agit, en effet, de régions dont le facies culturel est dans son ensemble plus archaïque. Dans le dernier cas, la répartition géographique semble d'autre part indiquer l'expansion de la charpente sur poinçon aux dépens de la cruck-construction.

Cette hypothèse plus raisonnable ne parvient cependant pas à en faire abandonner d'autres plus séduisantes, qui hantent toujours les esprits malgré la difficulté qu'on éprouve à les justifier. Hypothèses qui mènent de la répartition géographique d'un trait à l'affirmation d'une parenté culturelle entre les différents points de cette répartition et les groupes humains les peuplant : en l'occurrence entre Normandie et Scandinavie, entre Bretagne et domaine celtique.

De tels rapprochements semblent d'autant plus justifiés que le nombre des éléments comparables est plus grand. Or, dans le dernier cas, par exemple, à côté de la ' cruck-construction,' il faut noter également des analogies remarquables portant sur le plan, la façon de disposer des meubles ou un placard près de la porte d'entrée, la construction en clayonnage (wattle and daub) de la cheminée, etc. . . .

Les chances de rencontres polygénétiques ou de diffusion simple diminutent à mesure que les ensembles comparables d'un groupe humain à l'autre sont plus riches et de structure plus complexe.

Une enquête en profondeur et très détaillée met donc en présence une somme d'éléments culturels souvent insoupçonnés, dont elle fait entrevoir la distribution géographique. Mais elle n'aboutit pas seulement à une liste énumérative. Elle révèle des associations, des complexes, des organisations structurelles à la lumière desquelles la notion même de *type de maison* doit être revisée et affinée.

Ensembles et types

Si l'on considère des architectures très différentes telles que le chalet savoyard, la maison landaise ou la ferme cauchoise, la notion de type paraît absolument claire. Elle l'est aussi, si l'on prend comme représentatif de type un ou quelques éléments considérés comme discriminants : pente du toit ou matériau de couverture. C'est sur la combinaison de ces deux modes de discrimination qu'A. Dauzat semble s'être reposé pour

[1] Analogie qui avait frappé le Dr. A. Campbell. Cf. S. Erixon. Svensk byggnad, p. 454.

établir sa classification historico-géographique des maisons régionales en France.

Pour établir une typologie, A. Demangeon s'était surtout servi de critères morphologiques : concentration sous un même toit ou éclatement en plusieurs bâtiments ; organisation interne des locaux (étage, éléments longitudinaux ou transversaux). La répartition des types morphologiques ainsi dégagés ne présente pas de coïncidence remarquable soit avec les régions physiques ou historiques ou avec les genres de vie, mais elle fournit un vocabulaire d'un intérêt pratique appréciable.

L'une et l'autre de ces classifications sont des abstractions très simplifiées : La réalité est beaucoup plus diverse.

Peut-on par exemple parler de *la* maison normande ? Dans le seul département du Calvados, voici au moins deux ensembles caractéristiques différents. A l'est de la Dive, dans le pays d'Auge : l'exploitation herbagère dont les bâtiments en pan de bois et torchis sont disséminés dans une cour plantée d'arbres. A l'ouest, dans la plaine de Caen : l'exploitation de culture avex ses bâtiments de pierre rassemblés en cour fermée.

Dans une même région, dans un même village, c'est l'importance économique ou sociale de l'exploitation qui va réagir sur sa structure. Dans l'arrondissement de St. Flour, le journalier agricole habite une maison d'un seul local flanqué d'un toit à porcs mais la grande exploitation comprend sous le même toit une salle commune, cave, laiterie, une immense étable, un hangar surmonté d'un étage d'habitation et de vastes greniers. Extrêmes entre lesquels petites et moyennes exploitations présentent une gamme variée quant aux dimensions et à la complexité interne. En Sologne, la ' locature ' de l'ouvrier agricole comprend sous un seul toit une sallecommune, une laiterie, une étable pour une vache et une grange, tandis que la ferme moyenne a au moins quatre bâtiments sur cour ouverte.

Multiples sont les facteurs qui agissent sur l'élaboration et l'évolution d'un système architectural. Facteurs géographiques (climat, faune, flore, sous-sol, matériaux), historiques (rapports entre la maison normande et la maison scandinave, etc. . . .), techniques (adaptation à la polyculture, à la viticulture, à l'élevage, etc. . . .), économiques (régime de propriété, étendue de l'exploitation, rapport avex le marché extérieur, etc. . . .), sociaux (composition de la famille, rapports entre classes d'âge, entre patron et domestiques, représentation sociale, etc. . . .).

Chacune de ces composantes agit selon des modalités et une intensité variables d'un pays, parfois d'un village à l'autre. De là une grande variété de combinaisons dont la distinction est évidente entre centres culturels nettement différents, mais beaucoup moins nette dans les zones marginales.

A cette variété dans l'espace s'ajoute la variation dans le temps. L'évolution de l'habitation n'est pas toujours d'une clarté parfaite. En tout cas, l'enquête amène à reviser, dans ce domaine comme pour la plupart des phénomènes culturels, une conception trop fixiste de la tradition. Certes, des constructions très élémentaires (hutte de pierres sèches de bergers dans la vallée du Rhône, chalet savoyard à une seule pièce, etc. . . .) donnent l'impression d'une permanence séculaire. Par contre, l'évolution du plus grand nombre de maisons régionales peut être suivie objectivement, au moins depuis cent ans. (Dans le Perche, la maison change trois fois de formes et de matériaux de construction ; un peu partout la maison se segmente pour s'adapter aux nouvelles conceptions de l'hygiène et de la vie familiale.)

Un perpétuel effort d'adaptation et d'amélioration se fait jour. C'exerçant souvent sur des points particuliers (agrandissement ou compartimentage d'un local, transformation des ouvertures, etc. . . .) il aboutit parfois à des ensembles qui semblent parfaitement adaptés, en équilibre (maison-bloc du Doubs). Si l'on considère l'ensemble des données, la solution atteinte apparaît comme la meilleure possible et non comme rétrograde ou fixiste. Elle répond au mieux au genre de vie. C'est à ce parti architectural accompli, correspondant à un genre de vie bien assis et harmonieux que l'on pourrait donner le nom de type ou mieux de maison caractéristique.

Que le genre de vie lui-même s'altère et entre dans une période de transformation préalable à un nouvel équilibre, la maison perd elle aussi son équilibre fonctionnel. C'est le cas présent où les genres de vie sont attaqués par la civilisation machiniste et la transformation du régime de production, de distribution et de consommation nationale et mondiale.

Dans un monde en transformation, le programme est incertain, ainsi que le parti à prendre. D'où l'état précaire de l'habitat rural qui n'est lui-même que l'image de l'incertitude présente.

L'enquête confirme donc la relativité de certaines notions (tradition, pérennité, routine, stabilité des ' types ') et la nécessité, pour aboutir à une connaissance valable, de juger des phénomènes, non de l'extérieur et formellement, mais fonctionnellement, en se plaçant à l'intérieur du milieu culturel.

HORTICULTURAL CROPS IN RELATION TO WATER

BY

MR. F. A. SECRETT, C.B.E.

DURING this period of world food shortage it is essential that the best use is made of all available land. It would be foolish to increase further the vegetable acreage which was nearly doubled during the war years, but if more were produced from existing acres, land could be liberated for other crops. Many consider that an extension of the soft and hard fruit acreages would be beneficial. Land freed from vegetables could well be utilised for this purpose, and still be retained in the gross horticultural acreage.

Producers of food are concerned with three main factors :—

(a) To supply the maximum quantity that can readily be absorbed.
(b) To maintain the standard of quality that will encourage an expanding demand.
(c) To keep prices at a level which will encourage a constant flow of vegetables into every household.

It has often been asserted that irrigation is unnecessary in the British climate, but although this may be true in certain districts on the western seaboard, it is not applicable to dry areas where rainfall is limited to some 24 inches a year.

Plants perish without water, and if it is available only in limited quantities they are liable to suffer from pests and disease. Plants flourish if their total needs are satisfied, and even in the application of fertilisers success is dependent upon a sufficiency of water.

It is common knowledge that horticulture suffers from the effects of gluts and shortages. In periods of glut growers are seriously affected, and periods of shortage are a worry to politicians. In general national gluts and shortages are caused by climatic conditions ; prolonged periods of wet or showery weather produce gluts, whilst droughts give rise to acute shortages. Extremes of cold and heat also tend to upset the balance of supply and demand. Production could be evened-out and greatly improved by the application of artificial rain.

With an irrigation plant a predetermined crop rotation may be practised in dry periods which will greatly assist in evening-out supplies. Further, it is common knowledge that growing crops suffer during periods of drought and may often be brought to maturity speedily by the expeditious use of an irrigation plant. Quality is improved and the time of marketing made to synchronise with a period of shortage. This assists the grower in his grading and packing arrangements, and harvesting is spread over the season more evenly, thus eliminating the alternate periods of rush and slackness so common in the industry.

If it is agreed that artificial rain is of great assistance in evening-out supplies, it is also true that the weight of crops lifted per acre can be substantially increased. This is a most important factor as there is no surer way of lowering the cost of production than by increasing the tonnage per acre, and high tonnages and good quality invariably go together.

Recent research at Cambridge proved that the equivalent of 4 inches of rain greatly increased the weight of carrots per acre. In 1947 the effect of artificial rain on sugar beet was tested on the author's farm at Milford and the results were most interesting. The following information was supplied by Rothamsted Experimental Station who supervised the preliminary experiment and later conducted a fuller experiment in 1948 on a much wider scale.

There were six plots :—

Plots 1 and 6	Controls.
Plot 3	Irrigation with water only.
Plot 4	Water equal to that applied on Plot 3 but containing potassium nitrate in solution.
Plots 2 and 5	No water but an amount of solid potassium nitrate per acre equal to that provided by treatment 4.

There were seven irrigations beginning on June 25 and ending on September 26 ; the interval between watering varied somewhat but averaged 14 days. The total quantity of water applied to Plot 3 (water only) and to Plot 4 (water, plus dissolved potassium nitrate) was approximately 10 inches of rain per acre. The following were the main results of the experiment.

Clean Roots. The two irrigated plots gave a yield of 29·76 tons of washed roots per

acre, while the dry plots (mean of 4) gave 20·10 tons. Watering of about 10 inches rain per acre gave the handsome increase of 9·66 tons of roots per acre. Water containing potassium gave 1·63 tons of roots more than an equal amount of plain water, while solid potassium nitrate had no effect on root yield. These differences in the action of nitrate while not unexpected must be taken only as indications and need confirmation.

Sugar percentage. The dry plots gave 19·22 per cent. of sugar in the roots and the irrigated ones fell to 16·71, a drop of 2·5 per cent. The effect of potassium nitrate on sugar percentages was quite negligible.

Sugar cwt. per acre. In spite of the reduction in the sugar content watering increased the yield of sugar from 77·3 cwt. to 99·5 cwt. a gain of 22·2 cwt. per acre. As before there was the suggestion that nitrate in solution was effective while solid nitrate was not, the difference amounting to 8·2 cwt. of sugar per acre in favour of dissolved nitrate.

Tops. The luxuriant crop on the watered plots carried 14·48 tons of tops, whereas the dry plots had 9·25, the increase due to water being 5·23 tons. Potassium nitrate had no effect on top growth no matter how applied.

Plants suffer most seriously from insect pests during periods of excessive drought, and the judicious use of an irrigation system can be of great assistance in this respect. If crops can be kept growing and in good condition they are less liable to be attacked and, in fact, appear to put up a natural resistance.

Aphis is one of the worst pests on vegetables especially lettuce, and badly infested lettuce soon destroy demand. What we eat is largely a matter of habit, and once a market has been broken, it often takes weeks to recover. Attacks of Aphis can be controlled by applying artificial rain at the right time and in the correct quantities, especially if a weak solution of potassium nitrate is added to the irrigation water. The strength of the solution used is approximately 10 per cent. which is equivalent to 9 lbs. of KNO_3 in a solution of 10 gallons, and the rate of application is about 1 in 2,200. It has been found that these small quantities in solution give better results than larger amounts applied dry. Trace elements can also be evenly distributed over an area in any predetermined amount, from a few pounds upwards.

Plants growing on acid soils are more liable to be attacked by Aphis and other pests than those growing on neutral soils. Epidemics may occur on the latter, but it is unusual for the Aphis to be ever present as they are on so many holdings. A homoepathic dose of potassium nitrate, applied in the water, does not kill the Aphis but they migrate after its application.

Quick growth is largely responsible for succulence. Vegetables whose growth is delayed by water shortage are liable to become fibrous in texture and bitter or hot to the palate. True quality is closely associated with flavour. Many English people judge vegetables to be of good quality when they are pleasing to the eye, and ignore flavour and aroma but, subconsciously, they are seeking these virtues. If they are present, the housewife continues to buy, and so demand is maintained.

The production of high grade vegetables with their accompanying good flavour may be largely controlled in the following ways. Quality and succulence may be improved by raising new varieties, by giving good and correct cultivation, by maintaining fertility, by a sufficiency of water and the maintenance of freshness by correct harvesting and marketing methods. It will be clearly understood that water is a most important factor in all these operations.

By correct cultivation we encourage and maintain the water content in the surface soil. The use of humus for maintaining fertility aids the development of soil micro-organisms, promotes aeration, holds moisture, provides optimum conditions for root development and is conducive to a great population of earth-worms. The application of humus conforms to Nature's age-old law, from life to decay, and from decay to life again, the circle completed—a law which cannot be broken without penalty.

Flavour is thought to be determined largely by the ratio of sugar to starch in the plant, and if this is so the use of nutrients in the water is obvious.

After taking meticulous care with the production of a crop it is possible to reduce quality and flavour by bad handling during the twenty-four hours that elapse between severing the plant from the soil and its purchase by the housewife. On the continent most vegetables are sold unwashed as it is considered that washing should be done once only, when the vegetable is being prepared for cooking.

It is unfortunate that there has been no scientific investigation with regard to the improvement of nutritional values of vegetables by selection and general culture, and it is well to remember that nutrition and unpalatability are not synonymous terms. Vegetables which have not suffered at any period of their existence from a shortage of water are far more nutritive than those which have had to put up a fight for their existence. Succulence, aroma and nutritional values are all closely interlocked.

Turning to production costs, it is noted that production cost per acre is not so important

as the cost per ton, and there is no better way of improving quality and, at the same time, reducing production cost per ton than by ensuring the maximum weight per acre. Without increasing the present national vegetable acreage by a single acre, there could be at least a 50 per cent. increase in the quantity of vegetables grown, by giving the land all it required in knowledge, thought, skill, cultivation and fertility.

Like so many other forms of mechanisation in market-gardens, irrigation does not reduce the quantity or quality of labour needed on the holding, in fact the reverse is the case. On a highly cultivated and well watered vegetable holding mechanisation must centre round the irrigation equipment, and for this reason labour must always be available as occasion arises. Increased tonnages are obtained by speed of thought and action in using all the installation and services to best advantage. The timing of a crop may make all the difference between success and failure, between a heavy overdraft or a small balance.

The benefits of an irrigation plant are briefly :—

(1) The grower is no longer dependent upon the weather for providing the necessary moisture.

(2) Immediately the land becomes vacant, it can be worked and cropped again.

(3) If crops are backward through lack of moisture, their growth can be stimulated, and high plant population maintained.

(4) The quality and succulence of vegetables are improved.

(5) Pests and diseases, prevalent during periods of drought can be effectively controlled by the correct use of an irrigation system.

(6) If the irrigation plant is capable of running at high pressure, fertilisers or insecticides may be added to the water before distribution.

(7) Trace elements in any predetermined quantities can be easily and evenly distributed in solution.

(8) Production is speeded up during periods of drought when vegetables are in short supply.

(9) The range of crops can be increased considerably, to include summer Cauliflower.

(10) In general, experience proves that the proper and efficient use of artificial rain will double the output of a holding, even in normal seasons.

The approach to problems connected with the installation and use of irrigation has hitherto been of an empirical nature, and the knowledge that has been acquired has not been the result of scientific investigation. All this will be altered by the National Institute for Agricultural Engineering at their new Station at Wrest Park, and at the new Vegetable Research Station where these problems will be scientifically investigated.

An irrigation plant in the hands of the inefficient and unknowledgeable may become a serious menace to production, especially if used as a plaything. Water applied at the wrong time or in too great a quantity is liable to upset the balance of nature : how and when to apply the water are largely matters of experience.

When preparing land for seed it is preferable to water before cultivating, after weeds and residue of the previous crop have been removed. The equivalent of 1 inch of rain is usually sufficient to moisten down to a depth of 9 inches, and care should be taken that water is not applied more quickly than it can be absorbed by the soil particles ; on no account should the land be flooded.

Ploughing and sub-soiling may begin when the land has settled which normally takes from 12 to 24 hours. If the sub-soil is properly pulverised, sub-soil moisture will be attracted by the water applied to the surface, and provided a dust tilth is maintained evaporation will be checked. For planted crops irrigation before cultivating is preferable, but if, for any reason, the land is watered after ploughing it should again be thoroughly worked ; a crop must never be planted directly on to water.

When solutionising was first used the plants suffered considerably from scorching, and even now it is not uncommon to see crops so affected if watered in hot sunshine. To a large extent this difficulty has been overcome by the addition of oxygen to the irrigation water. This is accomplished by using a small compressor for displacing the air which is passed under pressure through an atomiser fitted across the inside of the main. Alternatively an airlift may be used to lift the water which, by these means, is thoroughly aerated and by being impregnated with as much oxygen as it is capable of absorbing, is brought in line with the natural qualities of rain.

It is to be hoped that research work on this and other similar problems will be undertaken in the near future, so that many present difficulties may be overcome.

(*Substance of a paper read to the British Association, Sept.* 1948.)

SCIENCE IN ADULT EDUCATION

Interim Report of the Committee established jointly by the National Foundation for Adult Education and the British Association.

In 1948 the executive bodies of the British Association and the National Foundation for Adult Education appointed a joint Committee to consider and report on the place of Science in Adult Education. The Committee, which held its first meeting in June, is composed as follows : *Chairman*, Mr. W. O. Lester Smith, C.B.E. *Members :* Mr. Edwin Barker, Prof. Winifred Cullis, C.B.E., Mr. R. D'Aeth, Mr. A. Clow Ford, M.B.E., Dr. J. C. Maxwell Garnett, C.B.E., Mr. R. L. Marshall, O.B.E., Mr. J. O. Roach, Dr. C. F. Strong. *Secretary :* Mr. E. M. Hutchinson.

The Committee presented an interim report to the Association and the Foundation in the Spring of 1949. It was received by the Council of the British Association on June 3 and approved, subject to discussion in the Section of Education during the Association's annual meeting at Newcastle in the first week of September. Owing to the establishment of the National Institute of Adult Education, embracing the work of the National Foundation for Adult Education and the British Institute of Adult Education, consideration of the report in this quarter has been delayed.

The prime intention of this interim report (the text of which is now published) is to focus attention on the need for increasing the number of full-time science tutors in University extra-mural work capable of stimulating demand and of recruiting and training part-time teachers. The report raises many problems which need further discussion but it is hoped that the argument justifies the limited conclusions and recommendations which are advanced.

Introduction

1. Under the general description of Adult Education, there are many opportunities for people to come together in order to exercise their personal aptitudes, to expand their abilities and to relate both to social activity. These opportunities range from teaching of university standard to informal groupings in clubs and community centres. Between these extremes lies the provision of evening classes by Local Education Authorities. Whether the emphasis is on formal study, informal discussion, or the educative influence of recreation in a specially designed setting, they are all based on the common assumption that education is in a high degree a social process.

2. A special feature during the present century has been the connection of the universities with the organising work of voluntary bodies, and in particular of the Workers' Educational Association. The intention of this link has been to carry the tradition of liberal and humane study beyond the walls of the universities themselves. This work appears at its best in the three-year tutorial classes, comprising 24 meetings in each of three consecutive sessions and providing for a close personal association between teacher and student, as well as for formal lectures and equivalent discussion periods. The student's contribution has included a definite programme of reading and writing and, in this way, particularly, has differed from mere attendance at popular lectures. Supplementing this high standard work, of which the beneficiaries can be reckoned annually in tens of thousands, the Workers' Educational Association, and in a smaller degree other bodies, have developed shorter and less personally exacting courses, imbued nevertheless with the same general intent. While such work has not reached more than a small minority of the adult population, it has been claimed that this minority has been of special significance for the orderly development on a broad basis of social and political responsibility.

3. There has, moreover, in the last 30 years been a marked increase in the number of people brought together for social and educational purposes by such bodies as the Co-operative organisations, Women's Institutes, Townswomen's Guilds, Community Associations, and Rural Community Councils. They are not necessarily adult education bodies in the sense of themselves providing a teaching service : they are concerned primarily to restore those ' community links ' which,

particularly in urban areas, as the Marley report on Satellite Towns long ago pointed out, are ' easily weakened and lost.' To the extent that they succeed in this main objective they provide an environment in which adult education broadly conceived can develop more abundantly.

4. Relatively striking expansions in the volume of formal educational work occurred both immediately following the war of 1914–1918, and again after the adoption of revised regulations governing State aid to the work in 1924, and it was in the second period of expansion that the question was first seriously raised as to whether the place occupied by subjects broadly grouped under the heading of ' Natural Science ' was adequate. Paper No. 8 of the Adult Education Committee of the Board of Education, published in 1927 under the title ' Natural Science in Adult Education ' concluded : ' Natural Science is being neglected in the adult education movement in comparison with other studies. 47 courses only out of 1,224 recognised under the Adult Education Regulations in the session 1925–26, were in Natural Science ; the number of students attending these courses was 935 out of a total of 26,806.' Various reasons for this slight interest in scientific subjects were put forward and recommendations were made which it was hoped might lead to an expansion of the proportions of such classes.

5. A further inquiry on similar lines was made by a committee, appointed by the British Association for the Advancement of Science, which reported to the annual meeting in 1933 and subsequently published its report under the title ' Science Teaching in Adult Education.' Extracts from both these reports are set out in Appendix I.

6. Since these reports were published, the whole world has been convulsed by a second war brought finally to a close by a spectacular example of the destructive power conferred upon men by the progress of physical science. The recognition that scientific progress raises issues of immediate personal, social and political consequence has been sharply enhanced by this one event, and if more slowly, even more pervasively, by a growing realisation that even the beneficial applications of science, resulting, e.g., in the saving of child life, may precipitate a new and formidable problem of providing food to fill the additional mouths.

7. Despite these and many other outstanding examples of the increasing influence of the natural sciences on individual lives and on social organisation, the place of science in formal adult education remains much what it was a generation ago. Although the total number of students enrolled in university extra-mural, Workers' Educational Association and similar classes has risen four-fold since 1925–26, the percentage of classes in natural science has remained constant, and it may be questioned whether the average quality of the work done in present-day classes is as thorough and systematic as it was twenty years ago.

It is quite certain that the popular science lecture no longer attracts a large and lively audience as it did in the nineteenth century. One part of the knowledge-seeking represented by those audiences has been increasingly better catered for as a result of the growth of technical education (both day and evening) made possible by the Technical Education Act of 1889 and subsequent legislation. But the opportunities thus offered have often inevitably lacked the intellectual sweep which characterised the public lecturing of the great popularisers of the nineteenth century. How to ' humanise ' or ' liberalise ' the average standard of adult work in the field of technical education is a vital problem now receiving much more attention, and it is to be hoped that the efforts in this direction will receive every support.

8. Without depreciating the work done in other recognised fields of study—in sociology, economics, philosophy, history, psychology, literature and the arts—the National Foundation felt that a further inquiry into the place of natural science in adult education was justified, and they therefore welcomed the initiative of the British Association for the Advancement of Science in suggesting the establishment of the present committee.

9. In preliminary discussions the committee decided that the general propositions advanced by earlier inquirers, as indicated in the extracts contained in Appendix I, are still sound. They recognised, however, that the concept of ' Adult Education ' as already indicated, has itself been broadened to include a wide range of community activities in which imagination and personal awareness of social responsibility are themselves seen as educational necessities. They also felt that an inquiry at this date must have regard to the relation between humanistic and scientific studies at school and university which has been a marked feature of educational controversy in recent years. In spite of the relatively small number of students reached by university tutorial courses and other classes for continuous study, the committee felt that these remain the most important single element in adult education. Special regard should be paid to the possible development of work in this field, whilst recognising that there may be opportunities of which full advantage has not yet been taken in the less academically inclined community groupings.

They therefore asked in the first place for information from university extra-mural departments, Workers' Educational Association districts and a limited number of interested individuals in accordance with the particulars set out in Appendix II. As a result of the facts elicited, the committee now feel justified in preparing this paper as an interim report.

What is 'Science in Adult Education'?

10. A term so general as 'Science in Adult Education' can have many interpretations. To some it means the formal teaching of science to adults in terms of the subject classifications familar in schools and universities, e.g. physics, chemistry, biology, astronomy, geology, etc. A limited amount of such teaching has long been undertaken, and it is sometimes claimed that only by close acquaintance with a particular discipline, involving personal experiment and intensive study, can adult students be introduced to the true nature and values of scientific method. Secondly, it can mean a due regard for the methods, nature and consequences of scientific discovery in the teaching of subjects, e.g. history, sociology and economics, which are traditionally 'Arts' subjects, and which have been the main field of academic adult studies apart from literature, music and fine arts. We believe that there is even less of this approach than there is of direct subject teaching, and we are supported by a District Secretary of the W.E.A. with wide experience, who records: 'What is striking to me is not so much the meagreness of the direct interest in science, but the inadequacy, to put it mildly, of the treatment of the significance of science in social and economic history and in other sociological subjects. This may be an explanation of our problem and the key to its solution. It may be more rewarding to give science its proper place within a number of subjects in adult education than to endeavour to develop it largely as a separate subject.' Finally, 'Science in Adult Education' might mean an attempt to relate the underlying facts of scientific discoveries and their applications to direct living experience without analysis into academic disciplines at all. It may, for instance, safely be assumed that for every person interested in the scientific theory of nuclear fission, many thousands are concerned with the possibilities of relief of pain and suffering by the medical use of radioactive isotopes: or, to take a more homely instance, the removal of household sewage is of vital interest to millions of householders, who care nothing for the theory of the nitrogen cycle. Each of these interpretations (and no doubt others) may be valid in relation to different groups of people, and we have something to say of each of them in later sections of this Report.

11. What, at least, we have no hesitation in asserting with the strong support of our informants is that a 'liberal' education must give due place in the whole social context to the nature and interpretation of the phenomena of natural science. It has been contended in *School and Life*[1] (pp. 102–3). 'That for a large number of men and women science has been enthroned as the authority and hope for man's future: for them science has displaced God, and the scientific tradition has eclipsed both the Christian and the classical lights.' We do not believe that any substantial number who have lost faith have 'enthroned' science in its place. It may be argued that the active religious community of former days included many who conformed from social expediency. Once the pressure of social conformity was released these latter, while ceasing to keep up appearances, certainly did not fly to a belief in science with its own requirements of ethical standards and effort. The great majority became increasingly apathetic and indifferent with, at most, a passing interest in the 'magic' and 'miracles' of science. The minority of vitally interested persons has undoubtedly suffered division against itself, but even here there is a great perplexity rather than the acute widespread change implied in the quotation from '*School and Life*' given above.

12. Daily experience of the results of applied science reinforces for most people the uneasy echoes of controversies with the details of which they are little acquainted, but which in essence are felt to have undermined established spiritual values. Until ordinary men and women can more clearly relate the findings of science to older conceptions of spiritual values, it is unlikely that their collective social and political behaviour will be successfully adapted to the new scale and character of world events. Indeed the following extract from the Report of the British Association Committee on Post-War University Education, although related to the undergraduate, can be applied equally well to the general population whom it is the business of adult education to serve: 'First, his spiritual education is plainly imperfect—his character or personality is impoverished—if he has never been thrilled by the achievements of the human intellect in scientific discovery, or if he knows nothing of the uses to which these discoveries have been put for the improvement of the material conditions of human life on this planet. Secondly, his education as a citizen is

[1] First Report of the Central Advisory Council for Education (England), 1947. H.M.S.O. 2*s.* 6*d.* net.

defective if his mind has no contacts with those of scientists whose help he may need in realising his ideals for the future of his community, his country, or his world : in peace as in war the political planner, whether a Minister of the Crown or plain John Citizen, must know where to seek scientific advice, and be able to understand it when he has found it. Thirdly, both his public work and his private behaviour are found to suffer if he lives in ignorance of the simple facts of everyday life in a scientific age. If, indeed, he knows no more than his great-grandfather did of the objects and methods of science with some illustrative facts, he is unfit for leadership, or even for living, in a material environment that has in large measure been shaped by scientific discovery and mechanical invention.'

13. We start, then, from the assumption that more study of the natural sciences and more understanding of their implications for personal and social life are legitimate aims for those concerned with liberal adult education, and we have attempted to analyse the reasons which at present appear to restrict access to such studies to little more than a handful of the general adult population.

A Background of Difficulties

14. All adult education is a voluntary matter so far as the students are concerned, and the extent to which mature people seek knowledge is clearly related to the purposes which they think it will serve and to the degree of respect for the educational process itself which they carry over from earlier years of compulsory education. There is very little evidence as to what actually motivates adult students in present-day classes : the work of the W.E.A. and of the University Tutorial Classes Committees is founded on the assumption that students seek education for ' social purpose,' and there is plenty of evidence that this was characteristically true of the earliest generation of students in classes promoted by these bodies. Motives to-day are more mixed, but we have one recent analysis (1946–7) covering students actually attending science classes, resulting from an inquiry undertaken by Mr. R. W. Crossland, a University Extra-Mural Science Tutor. Of 608 students, 19·1 per cent. regarded themselves as having a vocational interest, 46·6 per cent. a cultural interest, and 34·3 per cent. were attending for social, recreational and personal reasons.

15. On the evidence it can hardly be claimed that the years of compulsory schooling inspire any considerable number of ex-pupils to continue their education in any subject, except for frankly utilitarian purposes. This lack of continuity is particularly marked in scientific subjects, even among adults who have had the advantage of a Grammar School course, while the rest will have had so little genuine contact with science in school that they generally lack that basic knowledge of scientific method and terminology which is an indispensable foundation of further study. The development of Secondary Modern Schools and the growth of technical education should go some way towards solving this difficulty. But it is quite clear so far as the present generation of adults is concerned, that tutors cannot assume much familiarity with the terminology of science, still less with the mathematical background required for many branches of scientific study.

16. One tutor records ' The heterogeneous background of the students is one of the major problems of adult science teaching. In practically every class there is a range from the individual who left school at thirteen or fourteen years to the graduate, retired school teacher, civil servant or company director. On one course, " Science in Everyday Life," the students included a housewife, an engine driver, an electrician, a senior English teacher from the local girls' secondary school, a physiotherapist, a gardener and others. One wonders what were the pictures formed by these students when the tutor first mentioned the words—electricity, electron, positive and negative.'[1]

17. The science teaching so far undertaken in adult classes has largely followed recognised classifications, notably biology, geology and astronomy, i.e. it has been carried on in terms of our first possible interpretation (p. 133). But the real interests of students cannot be confined within the ordinary academic limits represented by these subject headings. ' One difficulty is the wide range of age, background knowledge and motives of students within any one class. In a sessional class on human biology one student wanted straight physiology in concentrated doses, a second wanted to learn how to teach hygiene in a junior school, a third hoped to get a lot of information on human problems in industry, a fourth was more interested in studying the relationship between the human mind and body, a fifth wanted to find the scientist's answer to " What is man ? " and so on. In the same class were two students just spending an evening at a human biology course ! '[1]

18. Another experienced tutor, comments that : ' It is a characteristic of adult education to be rich in demands for the study of

[1] R. W. Crossland, ' Science in Adult Education.' *Further Education*, Dec. 1948–Feb. 1949.

subjects which, at present, do not fall conveniently into the conventional divisions of knowledge made by the universities for their own purposes. This is a fact the implications of which have not yet been very much explored by educationists.'[1]

19. Problems presented by the nature of student demand and the inadequate academic backgrounds of students are further complicated by the division of attitudes on the parts of those to whom we must look for the supply of teachers. On the one hand it is claimed uncompromisingly that the nature of science and its consequences both for practical life and for spiritual understanding can only be grasped by severe and disciplined studies in one or other of the traditional special fields, and that almost by definition such work is beyond the possibilities of all save a tiny group of students such as are found in adult classes. Another school sees great possibilities in a historical or descriptive approach, concentrating on the applications rather than on the theory and proofs of science and directly relating these applications to problems of society. The growth of a belief that there is this possible field of work is perhaps the most notable development since the pre-war inquiries were made. As yet it lacks much verification in practice.

20. A further difficulty noted by a practising tutor is the ' unfamiliarity with science on the part of organisers and administrators in adult education (which) has put science courses at a disadvantage when in company with more familiar alternatives such as literature, history and social studies, they have been set before potential student groups for choice to be made of a subject of study for the ensuing year.' [2]

21. Supplementing these special difficulties are the all too familiar ones of defective accommodation, lack of equipment in many of the centres actually used and shortage of suitable books. Even in terms of a descriptive approach there is a wide agreement that students must have opportunity to ' see and touch ' for themselves and that access to laboratory facilities is essential for some types of courses.

22. The solutions to many of these difficulties must lie in the general developments now being projected by Local Education Authorities in their Schemes of Further Education. Although the Schemes so far published are sparing in their references to the particular problems we are discussing, they are sufficiently flexible for Authorities to be able to provide much of the necessary impetus if they are convinced of the need. Except as a short-term measure, no one welcomes the ' shift ' use of school buildings by children and adults, and the more usual objections are enhanced when access to laboratories and dual use of equipment is in question. In the larger urban centres we may hope for a growing use of colleges of Further Education, with suitable laboratory and other facilities, by groups concerned with Science not merely as an element of technical training but as a part of a truly liberal education : but the facts must be faced that, in smaller centres and certainly for a very long time in rural areas, premises and equipment will have to be improvised, and the village school will be sought out for adult classes because there simply is nowhere else to go.

23. If apparatus and, where necessary, transport for it can be made available, it will greatly ease the problems facing science tutors. There is a heavy physical strain on all adult tutors especially in rural areas, and if to inroads in time (for travel—considerably exceeding the actual time of teaching) are added demands on time and pocket for improvisation of apparatus known to be available in standard forms, it is not surprising that there is a dearth of tutors. ' Accommodation and equipment for the development of Science Teaching to adult groups ' might well figure on the agendas of the many local advisory committees which now bring together representatives of Local Education Authorities, Universities and Voluntary Bodies. If we refrain from discussing these points further it is not because they are unimportant, but because we wish in this report to concentrate attention on what we believe to be the central issue, viz. an increase in the number of appropriately qualified tutors.

The Importance of Teachers

24. Our informants have been in striking agreement as to the cardinal importance of teachers. Where tutors able to combine scholarship with understanding of the special difficulties mentioned above have been available, student demand has been stimulated and difficulties of accommodation and equipment have not proved insuperable. It is the old story that teachers are more important finally than niceties of accommodation, and how far the work actually done reflects this, is borne out by the following extracts from replies to inquiries :

> ' Perhaps the most successful General Science classes we have had (and they are very few) are those taken by a W.E.A. member who came into the Movement as a

[1] Dr. M. H. Clifford, ' The Place of Science in Adult Education.' *Adult Education*, March 1947.

[2] Dr. M. H. Clifford, ' Science in Adult Education.' *Nature*, April 26, 1947.

student in one of our classes. He is a Science Master at a Grammar School and since he has begun to understand the Adult Education movement he has undertaken some Science classes for adults.'

(Yorkshire Northern District W.E.A.)

(The success of one tutor) ' is largely due to his extraordinarily good use of films, film strips, charts, most cunningly devised questionnaires and duplicated diagrams, etc., which persuade people to do written work and read despite themselves.'

(Director of Extra-Mural Studies, Durham.)

' We have in previous sessions had some courses in rural places. The subject of these courses was " Science in Everyday Life " and was taken by the Professor of Chemistry here then. He had a special gift for popularising science and since he went science courses in the rural districts have ceased.'

(Professor of Adult Education, Hull University College.)

25. The importance of the tutor's personality is not a new discovery, as reference to the extracts in Appendix I will indicate ; indeed it is depressing to find a second generation of responsible field workers making the same comments as their predecessors as to the rarity with which these personalities are forthcoming, and it is important to try to find some explanation for the incontestable facts.

26. Returning for a moment to the difficulties outlined in the previous section, it may be worth while to note the suggestion as to the ' unfamiliarity with science on the part of organisers and administrators in adult education.' The conditions of pressure and financial limitation under which the work was carried on in pre-war years, and the tradition of responding to student demand, were probably two factors making against experimental appointments of a tutor-organiser type either by University Extra-Mural Departments or by Workers' Educational Districts. In that period also, the older type of large-scale university-extension lecturing which once provided a substantial number of introductory science courses was a less important element, in extra-mural work as a whole, than the promotion of tutorial classes.

27. Staff tutors in biology have not been unknown—e.g. at Leeds—but up to now, despite the recommendations of earlier reports, only two Extra-Mural Departments have made staff-tutor appointments intended to encourage the general growth of classes in natural science. The record of Cambridge and Birmingham, the two universities with special appointments, is important. In the Cambridge Extra-Mural area the percentage of classes in natural science subjects has risen in recent years to 16 per cent. against a figure of 4·5 per cent. for the country at large. The full-time science tutor for the area, states that ' At the present time the teaching of science within the area served by the Cambridge Board of Extra-Mural Studies could be at once expanded if more tutors were available, science courses having had to be refused on account of the scarcity of tutors.[1] The Director of the Birmingham Extra-Mural Department records that ' Indeed, the chief limitation on the growth of science courses is the availability of members of the Faculty of Science to take them.[2]

The Nature of Possible Demand

28. Before considering action to increase the supply of tutors, it is necessary to consider in more detail the character of the demand their services are expected to meet.

29. In the first place there are the students in Tutorial and Workers' Educational Association classes, varying within each class in social and educational background, but reflecting with different degrees of sharpness the main occupational groups in the area served. What these students share in common is a relationship to a movement directly concerned with the social purposes of adult education, and it has always been the desire of the Workers' Educational Association that tutors in their classes should identify themselves with the declared purposes of the Association.

30. Past experience has proved that a few exceptional tutors have been able to conduct classes, with such groups, in biology and geology particularly, and reach a very high academic standard. Notable recent examples in a field recognised as presenting special difficulties are the successful three-year tutorial classes in Oxford, tutored by Dr. K. A. G. Mendelssohn. The 1948 Tutorial Classes summer school at Balliol made provision for a group of 40 science students, in co-operation with the University Department of Physics. The 1948 report of the Tutorial Classes Committee records the opinion that ' no Oxford summer school should in future be organised without a section devoted to the study of science, for the introduction of organised science teaching

[1] Dr. M. H. Clifford, ' Science in Adult Education.' *Nature*, April 1947.

[2] D. R. Dudley, ' Some Recent Developments in Extra-Mural Work at the University of Birmingham.' *Tutors Association Bulletin*, Winter 1948–49.

met a long-felt want and set a standard of work which justified in all ways the decision taken by the Tutorial Classes Committee.'

31. Secondly, there has been in recent years a measure of re-orientation in the work of the University Extra-Mural Departments themselves with, in some instances, a marked expansion of work undertaken in conjunction with Local Education Authorities and voluntary groups concerned with special interests. Thus the Director of the Birmingham Extra-Mural Department in the paper referred to earlier writes that: 'The Staff Tutor in Natural Science has a most bewildering choice of contacts. Natural history societies, learned and technical associations, farmers, nurses, gardeners, engineers, dairymen, chemists, bacteriologists, fruit-growers—all Mural Studies claims that (in relation to *Extension* as distinct from *Tutorial* classes): 'It seems essential to link the course with an existing interest (e.g. horticulture, local geology and scenery, bees, child health and nutrition) in order to put the course on a sound educational footing and to secure a high standard of treatment. Where courses are arranged in this way it is usually possible to secure strong publicity through such magazines as 'Bee Craft' which cater for the same interest at a more practical level; and the students form a better class because they feel some affinity with one another from the start.' There is now a course on Plant Science, two on the Honey-Bee, two on Pond Life, one on Nutrition, and one on Social Biology. Others have been asked for, but

Subject Headings	All Students		Men		Women	
	Order of Preference	Interest Index	Order of Preference	Interest Index	Order of Preference	Interest Index
Medicine, Disease and Health –	(1)	7·7*	(3)	7·2*	(1)	8·5*
Future Advances – – –	(2)	7·4	(1)	7·7	(6)	7·0
Applications of Science to Industry –	(3)	7·2	(3)	7·2	(6)	7·0
Psychology – – – – –		7·2	(6)	6·6	(3)	8·1
New Discoveries and Theories – –	(5)	7·1	(2)	7·4	(10)	6·7
Pure ('non-useful') Biology –	(6)	7·0	(10)	6·2	(2)	8·3
Applied Biology and Agriculture –	(7)	6·7	(8)	6·3	(4)	7·3
Astronomy – – – –		6·7	(5)	6·7	(9)	6·8
Science of Everyday Things – –	(9)	6·6	(7)	6·5	(8)	6·9

* Average of numerical values attributed to interest shown, i.e.

10 —This interests me very much indeed.
7½—This is quite interesting.
5 —This is of moderate interest.
2½—This would not interest me much.
0 —This does not interest me at all.

can or should be interested in courses which deepen their knowledge of the scientific background. Last year there were twenty-five science courses in Birmingham, which may be divided into four grades:—

(1) Refresher courses at a graduate level, e.g. for teachers of sixth forms.
(2) Courses for other technical or professional workers, e.g. Genetics for farmers.
(3) Courses for the general public.
(4) Courses in Natural History at a more popular level, designed to recruit for more serious levels of work.[1]

32. A memorandum submitted by an officer of the London Department of Extra-

[1] D. R. Dudley, 'Some Recent Developments in Extra-Mural Work at the University of Birmingham.' *Tutors Association Bulletin*, Winter, 1948–49.

no centre has been found to take them. Similar evidence of new growth in 'University Extension' is forthcoming from several other universities.

33. There is finally the large group of adult students who attend vocational courses at technical colleges over several years and thereby acquire habits of serious study, and for whom the conditions of attendance and study especially at part-time courses, are a strong test of character. They are likely to prove particularly valuable recruits to adult education, not only for these reasons, but also because of the positions they will occupy in industry and commerce. At present many, if not most, of these students regard their education as finished with the completion of their vocational studies. They need to be made aware of the personal and social necessity of something more, but with the

long continued pressure of crowded syllabuses and lengthening courses of vocational training the problem is how to secure this.

34. The first need is that they should understand the application of scientific method outside their own field of study, and also the social implications and consequences of science and technology, especially their own. This must begin as part of the later vocational courses, through a wider treatment of work and study. Vocational education and adult education must not be regarded as two separate activities, chronologically determined : they should overlap, and the local College of Further Education with technical and general social studies being carried on in the same institution is best placed to ensure this. For the regional college of technology, with highly specialised courses, the problem is more difficult and an even greater effort must be made to bring to the notice of students the activities of University Extra-Mural Departments, the W.E.A. and other voluntary bodies.

This analysis of demand is of course based on the possibilities of supply of certain types of teaching. Such an analysis admittedly tells us little (except in regard to the recent ' extension ' activity set out in Paragraphs 31 and 32) about the interest which grows out of actual living experience. Something can be gleaned from the findings of inquiries directed to about 400 members of science classes (Extra-Mural and W.E.A.) during 1946–47 which revealed the following order of ' Interest ' ratings for the first 9 out of 23 selected subject headings.[1]

Remembering that these interest ratings come from the opinions of people already enrolled in a science group of some sort, it is the more striking to find ' Fundamentals of Physics and Chemistry ' ranking as low as nineteenth, rating 4·8 with men and 3·9 with women. What the figures do suggest is the possibility of a considerable growth in courses with scientific content if tutors are available : it is a matter of record that there are a large number of classes annually in psychology which it will be noted does not differ markedly in interest ' rating ' from subjects scarcely represented in present class lists at all.

35. We have stressed in this report the importance of making some knowledge of science available to the man in the street and of giving it a place equal in importance to the study of the humanities in all adult educational programmes. Conversely, students at technical and other vocational courses must be enabled to link up their scientific knowledge with a proper acquaintance with the humanities and it may well be considered the duty of liberal adult education to ensure that this bridge also is built.[2]

Increasing the Supply of Tutors

37. The qualities considered necessary in adult tutors in the Natural Sciences have frequently been suggested, but the suggestions do not always coincide. It is, however, generally agreed that tutors must first of all themselves be scientists with a thorough grounding in one or more special disciplines. But this is only a beginning. ' The social approach to science makes especial demands upon the tutor who will need to be widely read outside his own subject and able to recognise frankly his vested interest in the scientific outlook. . . . To-day the frontiers between Natural Science on one hand and psychology, economics and philosophy on the other, are often vague and difficult of definition. . . . Some men of science will consider it inappropriate to discuss these disputed fields in advance of a more complete study of them by the methods of science. But students will persist in bringing forward wide ranging issues in which science is involved.' ' Scientific workers when participating in adult education are not authorities addressing their professional equals, but expositors serving the needs of laymen. Their position closely resembles that of the political commentator attempting to assist public understanding of current affairs. Indeed they may even prove to be more effective as tutors if they can share some of the difficulties experienced by their students when surveying the territory of science.' [3]

38. So far there has been little indication that large numbers of trained scientists are seeking opportunity to engage in adult teaching work. On the contrary, the quotations on p. 136 suggest how rare and how highly prized are the occasional tutors who have emerged.

39. Two reasons have been advanced for

[1] For a full account of this research, see W. E. Flood, ' Science in Adult Education.' *Adult Education*, December 1948, pp. 67–74.

[2] For an expression of this view in vigorous—perhaps exaggerated—terms note Mr. Churchill's recent speech at the Massachusetts Institute of Technology, Boston :

> ' How right you are in this great institution of technical study and achievement to keep a Dean of Humanities and give him so commanding a part to play in your discussions. No technical knowledge can outweigh knowledge of the humanities in the gaining of which philosophy and history walk hand in hand. Our inheritance of well-founded, slowly conceived codes of honour, morals, and manners, the passionate convictions which so many hundreds of millions share together of the principles of freedom and justice, are far more precious to us than anything which scientific discoveries could bestow.'

[3] Dr. M. H. Clifford, ' Science in Adult Education.' *Nature*, April 1947.

this lack of tutors adapted to meet the possible demands sketched in the last section. The first is the absence of sufficient student demand to justify full-time tutor appointments by organising and teaching bodies and by advertisement to possible part-time tutors of the opportunities available. It is probably true for reasons suggested earlier that a view expressed by the Secretary of a Workers' Educational Association District would find widespread support : ' One of the principal tasks of the organiser of adult education,' he states, ' is the missionary job of interesting people as individuals and as groups, and it is never easy. Scientists must not expect adult education organisations to provide ready-made audiences, they must come in and help with the difficult missionary work. Until a good deal more pioneering can be done voluntarily, we are unlikely to consider the teaching of science in making full-time appointments, and it is unfortunately true that we have to make a black or white choice between the whole-way scientist and a non-scientist. There are few parallels in adult education with the science journalist.'

40. On the other hand it could well be argued that this view illustrates an unconscious bias and that a rapid expansion of science teaching depends on a courageous attitude to this question of full-time appointments. ' Where determined efforts are being made to stimulate scientific adult education there are indications that there is likely to be a student demand which cannot fully be met. So an obvious need is to appoint organisers who can put the case for science and to increase the supply of competent science tutors.'[1] A similar point is made elsewhere more cautiously ' Even within a democratic movement educational demand can be stimulated by officers having the necessary experience and information. Administrative officers should be sufficiently familiar with scientific thought and scientific activities to be able to interest their student members in scientists and their work.' [2]

41. The second reason sometimes advanced to account for the failure of scientists to come forward voluntarily in search of work in adult education is that the present education of scientists themselves is defective in important particulars. Certainly as compared with graduates in other faculties, it is unusual to find young scientists approaching University Extra-Mural Departments and Workers' Educational Association districts with requests for inclusion on panels of part-time tutors. This supports a widespread criticism in recent years that intense specialisation amongst university honours students and emphasis on the training of research workers operate against the production of graduates with a wide ranging interest in the social implications of their scientific work.

42. The Committee on Post-war University Education set up by the British Association, whose report was published in January 1944, gave particular attention to this problem. Their second term of reference was ' To consider replanning of teaching departments and curricula in accordance with modern conceptions of the inter-relation of different branches of knowledge, particularly those of science and the humanities.' ' Little is done,' to quote their introductory paragraph, ' to ensure that every undergraduate is faced with the need for working out a philosophy of life. Moreover, the separate specialisms tend to be increasingly divorced from the life of the community.' Alternative proposals were made including the possible institution of honours and pass schools of ' philosophy, natural and social ' ; the institution of ' special interest courses or courses and discussion groups of a more general nature on citizenship, social and industrial relations, anthropology, psychology or other branches of humanities.' This second approach, it was suggested, would be of particular value to ' students of the applied sciences, such as engineering, chemistry or medicine,' whose ignorance of the workings of democracy or its achievements in social welfare, it is suggested, is particularly marked.

43. It would certainly be beyond this committee's terms to pursue this problem in detail, and it would be unrealistic to suggest that a dearth of science tutors in adult education is in itself a reason for condemning the present approach to the education of scientists. But when that topic is already a matter of major concern the experience of adult education may suggest additional reasons for reform.

44. If it is agreed that defects in the basic education of scientists make them less willing than students of other disciplines to enter into adult teaching work and, when in fact they do enter it, render them less well fitted to perform the work than they might be, what can be done by way of subsequent training to remedy these defects ? Here again we enter a field of controversy extending beyond the limits of our immediate inquiry. There is at present only one full-time course provided for intending workers in adult education, and this so far has attracted a very small number of students. Partial training facilities are

[1] R. W. Crossland. ' Science in Adult Education.' *Further Education*, Dec. 1948–Feb. 1949. See also Appendix III for a description of the work undertaken in the Birmingham Area.

[2] Dr. M. H. Clifford, ' Science in Adult Education.' *Nature*, April 1947.

available through certain University Extra-Mural Departments either in seminars or in short-term residential courses, sometimes organised in conjunction with summer schools of the Extra-Mural Departments. Courses of the first type have been run in London during the present and two previous winter sessions, and resident courses for potential tutors have been run in conjunction with summer schools in recent years by the Oxford Extra-Mural Delegacy and the Cambridge Board of Extra-Mural Studies. The Cambridge course in 1947 was described as ' Intended for persons with suitable academic qualifications who need advice about conducting adult classes and teaching their subjects therein. Advice about teaching methods will be given by experienced tutors and there will be opportunities for meeting and giving practice talks to adult students. Background information concerning adult education and its development will also be given. Such courses do not claim to offer anything in the nature of a complete training, but they provide a valuable opportunity for would-be tutors to acquire some knowledge and personal experience preparatory to embarking upon an adult class.'

45. Details are given in Appendix III of the interesting efforts made in the Birmingham Extra-Mural area to recruit secondary school science masters into adult teaching, and there are several lessons to be gained from the experience recorded, e.g. the willingness to provide a service before asking for one ; the insistence on respect for the full-time teacher's pride in his laboratory and equipment.

46. The people whose help we want in the expansion of science teaching in adult education are for the most part caught up in other teaching or research. It will be a slow job to persuade them into acceptance of their power to contribute from their special knowledge to a wider field. They will not respond to general appeals : it is improbable that they will hear them. The urgent need is for an increase in the number of full-time tutor-pioneers who, because of their own scientific training, can honestly persuade their colleagues that there is a job to be done—different from, but not inferior to, their full-time occupation.

Inter-Relation of the Natural and Social Sciences

47. What has been said of the need for tutors who must be trained scientists, leaves largely untouched the second possible meaning which we gave to the term ' Science in Adult Education ' (p. 133).

If tutors in history, economics, sociology, are to show in their teaching ' a due regard for the methods, nature and consequences of scientific discovery,' they will have to familiarise themselves with the full meaning of these terms. This applies with special force to resident and organising tutors who, for the reasons given on p. 136 are by training almost invariably ' non-scientists,' and who at present tend to treat the natural sciences as subjects outside their competence to promote.

A test case of some urgency is provided by the UNESCO ' Food and People ' project deliberately chosen as the main topic on which to focus debate in 1949, precisely because it requires a full liaison between ' natural ' and ' social ' scientists. It is the first attempt on a large scale to convert what has hitherto been a vocational matter for scientists, into a non-vocational matter for everybody. It can reasonably be expected that tutors in social sciences will study the specially published material with particular regard to the various aspects of natural sciences—demography, biology, climatology, etc.—implicit in the theme.

This UNESCO project in fact provides an excellent basis for examination of the respective roles of tutors in Natural and Social Sciences which we commend to the Tutors' Association for study.

Conclusions and Recommendations

48. The following paragraphs summarise our main conclusions referenced to the numbered paragraphs in the foregoing Report which support them : arising from these conclusions we make certain recommendations which we hope will receive considered attention by the interested parties.

(a) For the reasons detailed, we think it is urgent to increase the relative importance attached to the natural sciences in programmes of adult education. (10–12).

(b) We have particularly in mind the teaching programmes of Colleges of Further Education, University Extra-Mural Departments and Workers' Educational Association Districts. (9)

(c) Difficulties in the way of expansion are :—

  (i) Lack of elementary knowledge of scientific terms and assumptions in large sections of the adult public. (15)

  (ii) Variety in ' real ' as opposed to ' nominal ' demand and conflict between the limits of academic disciplines and the living interests of students. (16–19)

(iii) General and special difficulties of accommodation, and equipment for classes. (21–23)

(iv) Shortage of suitably qualified teachers. (24–27)

(d) Given an increase in qualified teachers and a right attitude on the part of organising staffs, demand can be readily stimulated, but it does not necessarily express itself in terms of traditional subject classifications : more research along the lines indicated is needed on this. (28–35)

(e) The science tutor in adult education can reasonably be compared to the political commentator attempting to assist understanding of current affairs. (37)

(f) Our information supports the view that present university training of scientists does not tend towards producing people able to interpret a tutor's job in this way. (38–43)

(g) Special part-time training courses exist and can be developed ; direct efforts can be made to attract full-time teachers into part-time adult teaching ; the key to this sort of development is the appointment of more full-time organising-tutors—or, as we prefer to call them, ' tutor-pioneers.' (44–46)

(h) The whole body of tutors in adult education have a responsibility to show more regard for the importance of the natural sciences, especially in their relation to social sciences. This is exemplified in the UNESCO ' Food and People ' project. (47)

49. We recommend that :—

(a) University Extra-Mural Departments should make staff appointments of people competent to teach and organise classes in natural sciences ahead, if necessary, of ascertained demand, and since people holding such appointments will have an abnormal amount of work in recruiting and assisting part-time tutors, the Ministry of Education should recognise this in settling conditions of grant-aid for such appointments.

(b) Local Education Authorities should give special consideration to requests for assistance regarding accommodation, transport of apparatus, visual-aid equipment, etc., for science classes in outlying areas.

(c) The development of science in adult education with particular reference to the possibilities of a more liberal approach to vocational studies in Colleges of Further Education, should be discussed by local advisory committees for adult education.

(d) The Association of Tutors in Adult Education should give special attention through branch meetings and otherwise, to the relation in class teaching between natural and social sciences. The Association is probably the best body to initiate discussions with associations of science teachers and of scientific workers, with a view to increasing the number of part-time tutors.

(e) In the further development of part time training courses for new and potential tutors, University Extra-Mural Departments should pay particular attention to the needs of possible science tutors.

APPENDIX I

COMPARISON OF SUGGESTIONS AND RECOMMENDATIONS FROM EARLIER REPORTS.

viz. ' Science Teaching in Adult Education.' Report of a Committee appointed by the British Association for the Advancement of Science. Annual Report, 1933, pp. 330–357. ' Natural Science in Adult Education ' Paper No. 8 Adult Education Committee of the Board of Education, 1927.

---

1. Nature and Limit of Demand :

British Association.

' The demand for science teaching among adults varies at present directly with the supply of competent teachers.

The man is more important than the subject, and the subject than elaborate or expensive equipment.

Apart altogether from systematic vocational training (which is outside the scope of this inquiry) the approach must be from popular everyday applications of scientific method on practical occasions and common experience, to the discovery of principles, and from such discoveries, in detail, to the formulation of a systematic body of knowledge. It

is the scientific outlook, not a multiplicity of scientific experiences, that is to be achieved : as it has been expressed to the Committee " you are not making science students ; you are preaching a gospel " ; and providing what has also been described as a " useful adjunct to philosophy." '

Board of Education.

' Natural Science has, in our opinion, a claim upon the attention of the adult student, and is likely to prove particularly attractive to him for a variety of reasons ; of these we place unquestionably first its character as a humane study and its value in training the judgment, in stirring the imagination and in cultivating a spirit of reverence.

A survey of the existing provision of classes shows that the study of Natural Science is being neglected in the adult education movement in comparison with other studies. 47 courses only out of 1,224 recognised under the Adult Education Regulations in the session 1925–26 were in Natural Science ; the number of students attending these courses was 935 out of a total of 26,806.'

2. Factors retarding development :

(a) SHORTAGE OF TEACHERS :

British Association.

' This difference of aim and procedure, between science teaching for adults, and systematic science-teaching in Universities, or even in schools, goes far to explain the dearth of teachers qualified to conduct this sort of course. For here the teacher's own systematic knowledge can only be applied effectively by reversing academic procedure, and guiding (or provoking) the process of rediscovery, and of generalisation from facts actually observed by the pupil or the class in some episode of daily life.

While the historical approach to scientific problems provides, through its foundation in such experiences the most direct approach for adult classes, the prevalent neglect of the history of discovery among professional teachers of science is an important reason why teachers competent to teach science to adults are so rare.'

Board of Education.

' The greatest difficulty in the promotion of courses in Natural Science is likely to be that of finding teachers of wide knowledge who are capable of inspiring interest in Natural Science as the study of the conditions of human action. This is due in a great measure to the modern methods of teaching Science in the Universities. These methods have the object of producing specialists whose aim is the advancement of scientific knowledge within a closely defined field.

' Hitherto the adult education movement has offered so little opportunity of a career to intending teachers that it has not been possible to encourage men to qualify themselves while at the university for teaching Natural Science in its broader aspects in adult classes. We consider the practice recently adopted by certain University Extra-Mural bodies of appointing staff tutors to be an important contribution to the solution of the problem, and we recommend that all University Joint Committees promoting a considerable number of classes should appoint staff tutors for Natural Science.'

(b) LABORATORY FACILITIES NEEDED :

Board of Education.

' We doubt whether Physics is suited to the method of a University Tutorial Class, unless the conditions and type of student are both exceptional. Special apparatus is required by the lecturer, and considerable mathematical knowledge is required by the students for advanced study. These conditions cannot generally be met in the adult education movement. On the other hand, we consider that lectures on the wonderful developments in Physics which have taken place in recent years are at once most attractive and valuable to adult students, and are likely to stimulate the general interest in the achievements of Science which is a necessary background to scientific progress.

' There are probably greater difficulties in the way of the successful organisation of courses in Chemistry than in any other scientific subject. Nevertheless such courses have been organised and the importance of the subject is such that the difficulties and expense should be faced. Chemistry in the Home suggests itself as a subject of study most likely to attract adult students, particularly women students.'

3. Suggested Approaches to Subject Study :

British Association.

' Much adult science, which hardly goes even so far as such rediscovery and generalisation, has nevertheless its value as a conscious contribution to learning, through regional observation, and is capable of enhancement, and refinement of technique, especially when it is pursued as team work, in conjunction with other workers.

' Here is the proper field of what was formerly called " Natural History," as an outdoor occupation primarily, though it presumes the leisured revision and comparison of the notes and collections of field

workers, under the guidance of an experienced naturalist, who need not have academic or tutorial qualifications at all.

'This is where the adult class may reasonably appeal for help to the local Field Club or Natural History Society, and also to the local Museum. Both institutions stand to gain by enlargement of their range of field observers and voluntary collectors of regional material.'

Board of Education.

'The study of Biology has particular attractions for the adult student because it relates to facts within his experience, or readily to be ascertained by observation, and because the conclusions which he can draw have a direct bearing on his daily life.

'The evidence suggests that Biology can be taught effectively in a variety of ways and in any of the existing types of course promoted by universities and voluntary bodies. The method of the University Tutorial Class appears to be particularly well adapted to the subject.

'Laboratory accommodation and apparatus present fewer difficulties in the study of Biology than in many other scientific studies. A fully equipped laboratory is not indispensable for an adult class in Biology, but a permanent classroom is essential, and a supply of microscopes, if possible one to each pair of students, is desirable.

'Geology should be of particular interest to many adult students because their occupations depend on it, while others have many opportunities of studying geological material. The subject tends to be observational rather than experimental in character, and a lecture with illustrations is well adapted for certain phases of the subject. Specimens are easy to obtain and neither a laboratory nor expensive apparatus is indispensable.'

4. General Considerations :

British Association.

'The value of the work which is being done by certain voluntary and non-academic organisations should not be overlooked. More particularly the Women's Institutes in the country and the newly formed Townswomen's Guilds in the towns are bringing together large numbers of women unlikely to be touched by other bodies dealing with adult education. Up till now the instruction given in this connection has been mainly of practical character, but if lecturers with suitable outlook and interests were available much might be done through these organisations to stimulate an interest in achievement of science in relation to practical and social questions and to encourage a more scientific attitude of mind towards such matters.'

Board of Education.

'A type of course, which is not commonly found but which appears to us to be of much importance, is a course in the History of Science or in the Biographies of Men of Science.

'The following considerations are of general application to courses for adults in Natural Science.

(a) There can be little doubt that courses in Natural Science present greater difficulties in organisation, in obtaining suitable teachers, and in matters of equipment, than courses in other subjects which form the major part of the programme of adult education bodies. But the difficulties are not so great as is commonly supposed, and they have been met by certain bodies. Under able teachers the varying methods of University Extension Courses and University Tutorial Classes have been adapted successfully to scientific studies.

(b) It has been suggested that the deficiencies in the previous education of many adult students, particularly as regards mathematical training, militate against the success of courses in Natural Science. The evidence suggests, however, that this difficulty only assumes major importance in advanced studies in the Physical Sciences ; it has not seriously prejudiced the success of courses in Biology and Geology.

(c) The limitations under which University Tutorial Classes in Natural Science must inevitably work are such that an honours standard is not a possible aim for the class as a whole, and any attempt to impose a formal academic standard would embarrass the teacher and compel him to adopt a treatment of the subject which would not conduce to the success of the class.

'Summer Schools assume very special importance in the case of students in Natural Science. If such schools are held in a university town, it may prove possible to give advanced students the opportunity of using the university laboratories.

'In our Report on Full-time Studies we have set out our views on the importance of enabling selected students from the adult education movement to come to the university. We contemplate that among their number will be found some students in Natural Science courses, and that their contribution to scholarship and research will be of a high order.'

APPENDIX II

Copy of letter addressed by the National Foundation for Adult Education to Directors of Extra-Mural Departments, Secretaries of W.E.A. Districts and other interested persons.

THE Foundation has recently appointed jointly with the British Association for the Advancement of Science a Committee to inquire into the need for and if the need is accepted, the method of providing a larger place for the study and interpretation of science in programmes of adult education.

This Committee has now held two meetings and I have been asked to approach the likely interested parties to secure both information and opinions relevant to the inquiry. Set out overleaf are general considerations which the Committee has had in mind, and I shall be glad if in the light of these you will help in the following ways :—

(1) By saying whether in your experience the approach suggested is likely to be serviceable—are we in fact asking the right questions ?

(2) By submitting copies of any documents, particularly unpublished reports, which you think may be useful.

(3) By providing any statistics showing the trend of development in the teaching of natural sciences, especially in the sessions 1946–47 and 1947–48, together with an indication of the position that seems to be developing for the new session.

(The latest national figures available are those for 1945–46 included in the Ministry's recently published statistics. The percentage of classes in natural science and of students enrolled in them shows practically no alteration as compared with 1925–26, and we are particularly anxious to know whether in the post-war development there has been any marked change).

(4) By notifying us of any individuals or organisations with whom you are in touch who have shown a particularly active interest in the problems under consideration.

(5) By informing us to what extent full-time staff appointments have been made by reference to the qualifications of candidates in the teaching of scientific subjects.

Enclosure :

Considerations that led us to believe that an inquiry is necessary :—

(1) Natural Science still occupies too small a place in the teaching programmes of Responsible Bodies.

(2) The concept of ' Adult Education ' has itself broadened to include a wide range of community activities in which stimulus to imagination and personal awareness of social responsibility are themselves seen as educational necessities.

(3) The discussions now proceeding as to the relation of humanistic and scientific studies at school and university levels should also be extended into the field of adult education.

(4) There is a need to bring adult education as a *social* process into closer contact with the growing volume of broadcast and published material designed to increase popular interest and comprehension of scientific questions.

Questions to which it is thought answers should be sought :—

(1) Is there agreement that a ' liberal education ' is incomplete unless it includes understanding of the contributions of science to the ' ideals of integrity of thought, exactness of reasoning and devotion to new truth ' (*School and Life*, p. 102) ?

(2) If this is agreed, how far can this contribution be brought within the understanding reach of much larger numbers of people ?

(3) How far is this question part of the whole problem of giving adult education in all its forms, a larger place in personal lives ? Or how far does it present special difficulties because of the characteristic discipline of scientific education ?

(4) To what extent have the difficulties of accommodation, equipment and teaching services discussed by earlier inquiries been overcome ? What consideration is being given to these matters in Local Education Authority Schemes of Further Education ?

(5) How far do developments in visual aids—films, film strips, charts, etc., help in overcoming lack of laboratory and demonstration facilities in many of the places of usual social assembly, e.g. Community Centres ?

(6) To what extent has recent discussion on the social responsibility of scientists promoted new attitudes which seek an outlet in various forms of adult education?

APPENDIX III

Duties of a Staff Tutor in Science, with special reference to experience at Birmingham, May 1946–December 1948.[1]

1. When the Staff Tutor in Natural Science was appointed at Birmingham it was intended that he should :—

(a) stimulate scientific adult education (ALL kinds) ;
(b) conduct the minimum number of classes required by the Ministry of Education for grant, i.e. four classes per week.

This appointment was a pioneer one, and the Director was very keen that the Tutor appointed should get on with the organising work, i.e.

(a) Analysing the supply of tutors and demand for classes ;
(b) Surveying the already existing W.E.A. and similar groups, with a view to providing courses for their members ;
(c) Making contact with every Department in the Faculty of Science—making sure the Professor and *all* his staff know what Extra-Mural work is—and seeking possible tutors among these staffs ;
(d) Making contact with Resident Tutors in the area—enthusing them about science, and giving them some ideas of what type of courses might be run, and where tutors could be found.

2. In three years at Birmingham, which would normally be considered pioneer, no more was done than scratch the surface. There is so much to do in the adult science field with the ' responsive minority ' that the ' pioneer ' period must last several years, and a staff tutor will find his non-teaching and non-travelling time taken up fully with organising and pioneering.

3. Actually the title ' Staff Tutor ' in such circumstances becomes a misnomer. A 'Staff' Tutor usually only teaches (four nights a week) probably over a large area. A 'Resident ' Tutor does three nights teaching in his own area, plus organising. The Science Staff Tutor in Birmingham combined four nights teaching over a wide area, with organising over a wide area. The position has now been eased by the availability of an Administrative Assistant to relieve the Staff Tutor of much routine office work.

4. Apart from Teaching and Organising, the third aspect of a Science Staff Tutor's job is research. In the two winter terms this is impossible. Time required for research has to be made in the Summer Term—but there are other demands :

(i) Two weeks' Summer School.
(ii) Pioneering work—making contacts to plan next session's courses (excluding one's own)
(iii) Reading one's own subject.

5. The strain on domestic life of such pioneer appointments should not be overlooked. Absence from home extends to :—

(a) Four evenings a week (sleeping away one or two nights).
(b) Three or four Saturdays a term (whole day).
(c) Five or six week-ends (Friday to Sunday) a session.
(d) Two weeks in summer.

with an irregular time-table generally !

This problem is common to many sides of Adult Education, but in Science it has additional force because of the special problems facing pioneer tutors—particularly when there are so many alternative highly paid appointments open to well qualified graduates.

A METHOD OF RECRUITING GRAMMAR SCHOOL MASTERS AS PART-TIME TUTORS IN ADULT EDUCATION, BASED ON EXPERIENCE IN THE BIRMINGHAM EXTRA-MURAL DEPARTMENT.

1. This experience at Birmingham occurred at a time when Voluntary Bodies and L.E.A.s were beginning to accept the co-operative intent of the 1944 Act, and approaches made to L.E.A.s and Headmasters for use of labs in the evening received sympathetic consideration.

2. The Birmingham idea was to hold Terminal (12 meetings) or Sessional (24 meetings) Courses, taken by the Staff Tutor in Science, in four Centres per session. Resident tutors did most of the organising and liaison with the L.E.A., but the Staff Tutor visited Grammar Schools—sometimes alone, sometimes with the Resident Tutor—to explain to the Headmaster and relevant Science Master what facilities were wanted, and to allay fears that the lab would be destroyed. A Grammar School in the Birmingham area rarely refused facilities to a member of the University Staff. In four instances at least one local science teacher joined a class as a student.

3. By taking great care to keep the lab clean (no cigarette ends, no ink spilling, etc.) a welcome was won in the schools. Several

[1] Based on notes prepared by the Staff Tutor, Mr. R. W. Crossland.

schools are used for other classes, and in a few country towns a Grammar School Headmaster holds an office in Adult Education—e.g. Chairman of local W.E.A. branch, which is helpful.

4. The next stage was to persuade a local science master to take on a class in his own lab—when he would be free from interference from visiting tutors. In six cases this persuasion was successful. It should be said that there were two or three science masters taking classes in their own labs when the Staff Tutor appointment in Science was made, and it is too early to judge the success of the scheme. Apart from the pioneer stage of 'stimulating scientific adult education' there remains the continual recruiting of new science teachers to :—

(i) Replace those who leave an area ;
(ii) Relieve a teacher who has taken a course for one or two or more years ;
(iii) Take science courses to outlying areas (i.e. away from the grammar school).

5. Help is given to part-time tutors by holding Week-end and One-Day Schools on 'Teaching Science to Adults.' One such Day-School was a joint meeting with Bristol University part-time science tutors.

6. It must of course be recognised that the best grammar school teachers are busy people—often working *at* school until 5.30 P.M.—then marking and preparing work at home in the evenings. They give their whole energy to the day job—and they are not without domestic responsibilities. Nevertheless, with very few exceptions, schoolteachers and University teachers who, under 'persuasion' took on adult classes, said how much *they* had got out of the course (i.e. as tutors). Schoolteachers said the evening work helped them to see the day-time teaching in a new perspective, and also gave them a contact with some of the parents of the children they teach. University teachers find that evening work gives them contact with the world outside the University and keeps their 'feet on the ground.'

AIR PHOTOGRAPHY AND GEOLOGY[1]

DR. H. HAMSHAW THOMAS, F.R.S., opening the discussion, said that the value of air photographs to the geologist became evident in 1916 when parts of the Sinai peninsula were photographed from the air by members of the Royal Flying Corps. The subsequent photographic air survey of South and Central Palestine revealed many features of considerable geological interest, some of which were described by the speaker in a lecture to the Geological Society of London in 1919. Soon afterwards geologists in the Middle East and other parts of the world began to use air photographs to aid their field surveys and during the past twenty years a very considerable body of knowledge and experience had been gained. But while, in the past, air photographs had been available to relatively few field geologists and had involved considerable financial outlay, it was now possible for scientists to obtain aerial news of many parts of England and Scotland at very cheap rates by the generous co-operation of the Air Ministry. This new aid should prove of much value in research and teaching and consequently all geologists should make themselves acquainted with the characteristics and properties of air photographs and with the way in which they could be used.

The air photograph was more than a picture of the ground. It depicted in considerable detail all the surface features on a scale or scales mathematically related to the focal length of the camera lens and the distance of the aircraft from the ground Pictures taken with a camera whose optical axis was perpendicular to the ground would be found most useful, and there were generally taken in an overlapping sequence so that the same area of ground was depicted from two different points of the sky. The examination of pairs of successive prints with a simple stereoscope would show the relief of the ground and the relative heights of adjacent objects, often in a most remarkable manner. Photographs taken with a camera so placed in the aircraft that the optical axis made an oblique angle to the horizontal are often preferred by the beginner as being easier to understand. But in these views the scale of the picture is not uniform, it varies from the bottom to the horizon or to the top of the print. For this reason they are often difficult to relate to a map and they can prove misleading. Full use of air photographs requires considerable practice and a knowledge of the ground

[1] Report of a Discussion in Section C (Geology) at Brighton, September 10, 1948.

depicted. The information which they yield is usually proportional to familiarity with the surface features possessed by the user.

It is often impossible to identify all the things shown in a photograph without a study on the ground of a representative part of the country depicted, since all the objects on the surface are seen from an unfamiliar view point. When, however, the objects of geological interest have been identified in the photograph their position on a map can be quickly recorded by using proportional compasses, or other simple instruments. It may often be found useful to correct or amplify the topographical detail of an old map before adding geological information.

Air photographs taken over Britain must not be expected to show the same wealth of geological information as those taken over the arid or semi-arid regions of the Middle East where there is little vegetation cover to obscure the outcrops, of the rocks. But geologists who are mapping in upland areas will generally find that if they take air photographs with them on the ground their work will be greatly helped. The exact position of significant outcrops can be readily located on the photographs and rapidly transferred to their map. Air photography is an invaluable help to those who are working in areas where the ground detail is very complicated and where topographical maps do not show the actual surface features. It is also very useful in the study of coastal areas where the topography of the coast lines and of tidal lands is constantly changing, and where the ordnance survey maps soon become out of date.

Aerial Photogrammetric Survey Applied to Geological Mapping

by

Mr. P. G. Mott

A necessary basis for most geological information is a map. It follows as an obvious corollary that the accuracy of the information contained in a geological map is largely dependent on the accuracy of the topographical map sheets on which it is based. Unluckily for the geologist the best mapped regions of the earth are certain to be those in which the geology is already well known. More often than not, the geologist as well as the surveyor finds the greatest scope for his work in the undeveloped areas where maps are either non-existent or inaccurate. For this reason, in the future as in the past, surveying and geology must necessarily go hand in hand. Whereas formerly it was always the surveyor who tended to lag behind the geologist, the advent of air photography and its attendant science of photogrammetry has so revolutionised the whole process of topographic mapping that it is likely to be the geologist and not the surveyor who finds himself a step behind in the future.

We have in the vertical air photograph, provided it is taken with a suitably calibrated precision air camera, the raw material for the production of a contoured topographical map in which accuracy and wealth of detail may be fairly claimed to compare with anything that was ever executed by the older and slower method of plane-tabling on the ground.

Both the initial cost of the flying and subsequent cost of photogrammetric mapping are largely dependent on the number of exposures necessary to cover an area. It is, therefore, of importance to the geologist as well as to the surveyor to give very careful consideration to the choice of a suitable negative scale which fills both practical and economic requirements. The factors influencing negative scale may be briefly summed up as follows :—

(i) Ability to interpret accurately all features appearing on a map of the scale required.
(ii) The service ceiling of the aircraft which is used to carry out photography.
(iii) The degree of enlargement from negative to map scale.
(iv) The interval of contouring if required.

For general exploration work it is convenient to the geologist to have the greatest area possible on a single print. With this in mind there is at present, in my opinion, a dangerous tendency in geological circles to demand the smallest possible negative scale, with the idea that the smaller the scale the greater will be the area contained in a single photograph. In fact it is not the negative scale which influences the area included in a contact print, but the angular field of the lens and the service ceiling of the aircraft ; thus a 9 in. × 9 in. negative taken with a 6 in. lens from an altitude of 18,000 ft. would cover an area of approximately 26 square miles, whereas a 5 in. × 5 in. negative with a 3¼ in. lens from the same flying height would cover an area of 27 square miles. In the former case the negative scale would be 1/36,000 and in the latter 1/66,500.

At present there is no civil aircraft economically and practically suited to survey photography which can go higher than 22,000 ft. In the tropics it is extremely difficult to get any normal aircraft above 18,000 ft. In practice, therefore, it should be accepted that the absolute minimum negative scale designed to cover both the requirements of geological exploration and

small scale mapping is 1/35,000 on a 9 in. × 9 in. negative taken with a 6 in. lens from an altitude of 17,500 ft. above the mean level of the terrain.

Different types of mapping require different types of camera lens. Long focal length lenses produce very little height displacement and are very suitable for large scale mosaics, the production of rectified enlargements, and detail maps (without contours) at scales up to 25 in. to the mile The stereo impression of relief is slight with a long focal length lens and the ground appears flatter than in nature. This type should not, therefore, be used for form-lining or contouring. Lenses with a normal field, *i.e.* giving an angular field of 65°., produce a stereo image which is very nearly true in its impression of height : this type is suitable for contoured maps and plans at scales of 1/10,000 and larger.

There exists to-day a very wide choice of instruments and methods for photogrammetric mapping resulting from world-wide research over the past 30 years. There is, however, no method yet devised by which air photogrammetry can be completely divorced from work on the ground, nor, in my opinion, is this ever likely to occur. A framework of control points, the height and position of which must be established by normal ground survey, is essential to the construction of any map whether it be made from air photographs or not—the idea entertained by some that it is possible to feed in a photograph at one end of a machine and churn out a map at the other is, of course, so much nonsense. The extent and disposition of the control framework provided on the ground varies considerably according to the method employed in plotting the air survey.

By the use of radar or radio aids it is now possible to measure with great accuracy the distance between two points as far apart as 300 miles and it may well be that most, if not all, major triangulation will be carried out by this method in the future. Radar has also been used to fix the position of an aircraft in space so that at the instant of each photographic exposure the coordinated position of the point on the ground immediately below the centre of each photograph can be fixed to an accuracy sufficient for small scale mapping. With further research the precision of such fixes is likely to be greatly increased. The employment of radar in this way has recently been of great value in the tracking of aerial magnetometer surveys for oil exploration in the Bahamas and elsewhere. It must be remembered, however, that radar is still an expensive tool requiring elaborate facilities which cannot be justified economically, except in cases where the survey extends over very large areas amounting, to say, 40,000 square miles of photography per annum.

Where the ground relief is less than 10 per cent. of the altitude of the aircraft above ground, and a map without contours is required, it is possible by graphical and semi-graphical methods to extend a chain of interlocking triangles between selected points of detail on the photographs and to ' tie ' these in for scale and azimuth within a limited framework provided by ground triangulation.

Semi-graphical mapping of this type is extremely rapid. For example 6,000 square miles of Arabia were photographed and mapped during 1947 in 10 months, including flying and photography, ground control, and the production of maps covering the whole area at 1/50,000.

In mountainous country, where the effect of terrain relief rules out the use of two-dimensional plotting, or where the requirement is for precise contouring, photogrammetric mapping is carried out by means of an instrument employing the principle of space vectors, whereby the corresponding rays emerging from identical objects of detail on a stereo pair of photographs are made to intersect in ' space.'

The simplest form of space plotter is the stereo Multiplex which one may realise as a row of projectors strung along a horizontal bar. Each projector may be considered to be a replica of the taking camera and by rotation in three directions can be made to assume a position identical with that of the camera in the aircraft at the moment of exposure. By means of coloured filters the images of alternate pictures along the strip are projected in red and blue. When viewed through spectacles of identical colours, each eye sees only one picture and a stereoscopic impression is obtained of the earth's surface in miniature. Plotting of detail and contours in the Multiplex is carried out by means of a small movable ' tracing table.' The table itself can be raised or lowered vertically, and contains in its centre a pin-hole which is illuminated from below. The effect of this hole is to produce a point of light which appears to ' float ' in the stereoscopic image projected on the tracing table. If the height of the tracing table is set by means of a micrometer screw to read the level of a particular contour then the floating mark can be made to follow the line of the contour which at the same time is traced by a pencil fixed immediately beneath the pin-hole or floating mark. For larger scale mapping and closer interval contouring it is necessary to use a more precise type of instrument, such as the Stereo-autograph made by the firm of Henry Wild of Switzerland.

The basic principles of the Autograph are

the same as those of the Multiplex, but in place of a projection system the paths of the light rays are reconstructed by mechanical rods and examination of the photographs takes place in a binocular system employing a very high degree of magnification.

The accuracy that can be achieved by such precise instruments as the Stereo-autograph is very great indeed. From photographs taken at a flying height of 4,000 ft. above ground it is possible to contour at intervals of 5 ft. The order of accuracy of spot levels may be from 1 to 2 ft. With such instruments large-scale cadastral plans suited to the requirements of the development engineer can be produced at a speed far in excess of ground methods alone. Such surveys can be checked at any time without having recourse to visiting the site, while the photographs themselves provide a detailed historical record of the progress of development.

As might be expected, photogeology and photogrammetry have developed into separate sciences, each requiring a specialised technique, but both are dependent on a common source of material—the air photograph.

The important thing is for the geologist and the air surveyor to work in close liasion so that each can appreciate the problems which beset the other. Given this mutual understanding there is almost no limit to the assistance with which air survey can provide the geologist at all stages of his work.

Photogeology as a Stage in Mapping

by

Mr. P. G. Evans

The stereophotograph taken from the air provides the field geologist with a new tool which has already proved of great value. He can study in detail an optical model of the landscape with a much exaggerated relief. The information obtainable is greatest in areas of young topography, made up of sediments of varying resistance to erosion, and having a bold but not complex structure. Areas of mature relief or very complex structure yields less evidence. In barren well-exposed country the photographs can readily be converted into a geological map and field-work can be limited to the more accurate measurement of dips and thicknesses, the investigation of lithology, and the collection specimens. In jungle-covered country, the scarps, dip-holes, and strike-valleys give much indirect evidence which can be combined with field work to produce a map which in most cases is superior to a map based on field-work alone. There are various possible schemes for combining field-work with photogeological work, but it is desirable for every field geologist who has normal stereoscopic vision to be able to interpret photographs of his own area, although in a large organisation it may be convenient also to have a photogeologist at headquarters. Whatever the arrangement may be, the close coordination of the field-work and photogeological work is essential.

Mr. Evans illustrated his paper by a series of very remarkable lantern slides which provided convincing evidence of the value of air photography to geologists in the Middle East and elsewhere.—Editor.

Geology and Air Photography

by

Prof. David L. Linton

Progress in any science may be due to either improved understanding of observed phenomena or improved observation.

Most scientific apparatus is designed to serve the latter end, much of it to extend our powers of vision. But though the telescope assists the topographic surveyor and the microscope aided by the Nicol prism has been the indispensable tool of the petrologist, the field geologist has thus far depended on the unaided power of his own eyes. The first point to be stressed is that aerial photography offers a powerful extension of the geologist's vision. It allows him to see the earth in a new way. This is no mere figure of speech, but sober truth. The view of the earth is new, first because the viewpoint is new—1 to 3 miles up; and second because the aerial camera with its relatively long focus lens (3 to 52 in.)—sees objects that could not be discerned by the human eye from such heights, and thirdly because the power of stereo vision that we have from the possession of two eyes is not lost, but on the contrary can be powerfully enhanced by using the aerial viewpoint. Thus arises the unique combination of characters that makes the air view a powerful extension of vision that geologists cannot afford to ignore. The air view allows the observer to survey a wide field and thus see directly space relationships that can otherwise only be inferred as the result of ground survey and at the same time to see in detail and to see three dimensionally. Air photography is not therefore something which geologists can take up or disregard at pleasure. It is like the microscope or the Nicol prism a fundamental extension of vision which must be tried and developed.

Mr. Mott had considered the aid which it can provide in making the basic topographical map. As he claimed, this is an invaluable service, in many parts of the world, but of greater interest perhaps in the present

discussion are the means by which air photographs add directly to the observational data of field geology.

First and foremost is the direct appreciation which they permit of structural relationships. Probably everyone in the room had seen some photograph from the barren lands of the Canadian Arctic or the arid wastes of Iran in which dip strike and outcrops, foliation, folding or faulting are portrayed with breath-taking clarity.

But mention must be made also of the limitation which climate imposes on this method. It is essentially a method of the arid and barren lands. Humid lands with a continuous cover of vegetation and crops are in some measure disguised and, though the indications of surface form and surface vegetation are still of great value, ground survey is necessary to interpret the photographic indications and as Mr. Evans rightly claimed the combined method is superior to either separately.

The use of air photographs in geology is often thought of as being limited to the interpretation of structure. This is not so. Another very large field is concerned with the with the mapping and interpretation of *Holocene* deposits. These are often so young that they are as yet little weathered or invaded by vegetation, and are therefore conspicuous features in the air view. A vertical photograph of Vesuvius allows the principal historic lava flows to be readily indentified and precisely mapped. Photographs of the glaciers of the Norwegian Jotunheim and Jöstedalsbre show very clearly the modern moraines of fresh unweathered debris, the well-known eighteenth century moraines now covered with lichens and mosses, and the still older moraines with more extensive vegetation cover. Accumulations of marine and fluviatile alluvia can be subjected to similar analysis and mapping, and the same applies to the blown sands of shores and deserts. Many of these deposits moreover are relatively inaccessible and difficult to map by normal means and not the least advantage which the air view offers to the geologist is that of complete mobility.

A third field in which geologists have much to learn from the application of air photography is the study of physical processes. A photograph taken to-day of any area is a record of things as they are in that place and is available for comparison with photographs of the same area taken a year or a century hence. Quantitative estimates of change can thus be made and weathering, erosion, transport and deposition become processes subject to measurement.

Finally it should be added that whereas air photographs add to the observational data of geology, they can also be used as the best means of presenting the evidence to other workers in the same field. Stereo pairs in the form of anaglyphs can be reproduced in the proceedings of learned societies and thus allow 3-dimensional presentation of field evidence from often inaccessible localities to be made available to all interested workers in just the same way that the results of specialist investigations under the microscope can be made available to all in photomicrographs. Geographers have already shown what can be done in this respect by presenting the evidence in a morphological investigation in this way [1] and it is to be hoped that geologists will not be slow to follow.

Discussion

During the general discussion Mr. S. H. Beaver dealt with the employment of air photographs for elucidating the geological structure of Great Britain. He had found that the areas in which the structure was clearly shown were not numerous, though in the Craven area the geological features were well shown. Changes in the appearance of the vegetation, related to changes in the nature of the underlying rocks, were often visible and provided a feature which might be useful. He drew attention to the large collection of air photographs of Great Britain held by the Ministry for Town and Country Planning, which could be inspected by geologists.

Other speakers referred to the poor quality of many of the photographs taken by the Royal Air Force over Britain. It was, however, pointed out that the weather conditions in the British Isles were very different from those in the Middle-East and that cloudless skies were of infrequent occurrence. It was also stated that most of the British photographs were the work of the Royal Air Force personnel undergoing training and consequently their work could not be fairly compared with the photographs obtained by the highly skilled technicians who form part of the staff of Civil Air Survey Organisations.

[1] C. M. Mannerfelt, "Några glacialmorfologiska formelment och deras vittnesbörd om inlandsisens avsmältningsmekanik i svensk och norsk fjällterräng," *Geografiska Annaler*, Vol. XXVII, 1945, pp. 2 ff.

MALNUTRITION AND RESISTANCE TO INFECTION

BY

PROF. J. R. MARRACK

As a rule a fall of standard of nutrition is accompanied by overcrowding, exposure, dirt and fatigue, that are enough to account for any increase of disease ; there is no clear evidence that malnutrition is a contributory cause. But, in a few instances, the standard of nutrition has fallen while the standard of life, in other respects, has not changed. A large amount of milk products was exported from Denmark to Germany during the early years of the first world war. The diet of the Danes suffered in consequence. As is well known the incidence of keratomalacia rose steeply during these years ; at the same time the T.B. death rate rose by over 25 per cent. After the end of 1917, owing to pressure by the British Government the export of food to Germany was stopped and the food retained was eaten by the Danes. The T.B. death rate fell in the following year to the 1914 level, whereas in nearly every other country in Europe it rose above the 1917 level. There is no reason to suppose that the standard of living in Denmark fell up to 1917 and rose in 1918, except in respect of nutrition.

Such instances seem clear enough, but there are puzzles. Why, for example, should the T.B. death rate in the British and American zones of Germany remain low in spite of undernutrition far worse than Denmark suffered in 1917? And there is evidence that malnutrition reduces the susceptibility of animals to certain diseases. We want to know more about the effect of nutrition on defences against diseases.

Vitamin A

Years ago Mellanby and Green suggested that vitamin A might be called the anti-infective vitamin ; and the belief still persists that doses of vitamin A may protect against colds. When experimental animals are deprived of vitamin A the cells of some of the passages of the body, in the respiratory tract for example, change, and come to resemble the cells of the outer layers of skin. With this change one of the important defences breaks down. The changed cells have no cilia to sweep bacteria that may get down into the smaller bronchioles up and out of the respiratory tract. Also the changed cells desquamate off and block the smaller air passages. Hence animals deprived of vitamin A are liable to bronchopneumonia.

How far this change of lining cells occurs in man is uncertain. We know that severe deficiency of vitamin A causes this change on the front surface of the eyes. A rather similar change may be found in the mouths of hair follicles, but whether this change is due to deficiency of vitamin A is disputed. It seems that no extensive investigations have been made into the frequency of this change in the respiratory tracts of human beings. When the morbid anatomist notes it he ascribes it to irritation or inflammation ; the nutritionist ascribes it to deficiency of vitamin A. Children with congenital cystic disease of the pancreas have a limited ability to absorb vitamin A. They almost always die before they are 5 years old of infection of the lungs. The characteristic changes are found in their smaller air passages. The nutritionist holds that these changes are primary and that the inflammation is secondary to them ; the morbid anatomist, that the changes are secondary to inflammation.

Certainly there is no evidence that people who have gone without vitamin A for long periods, by way of experiment, are abnormally liable to colds or other respiratory infections. In the longest known experiment, some of the subjects went without vitamin A for two years. Nor is the evidence that doses of vitamin A will reduce the incidence or severity of colds satisfactory. But I think that it is possible that lack of vitamin A may be one of the factors that reduces the resistance to tuberculosis. Vitamin A was the nutrient whose supply in Denmark fell most when the tuberculosis death rose during the early war years and rose again when the death rate fell at the end of 1917. The lack of vitamin A was shown by the steep rise in the frequency of keratomalacia (which is undoubtedly due to deficiency of vitamin A) and the sudden fall in 1918. Some experimental evidence also suggests that deficiency of vitamin A may make human beings more susceptible to tuberculosis.

Antibodies

Antibodies are proteins and can be made only from proteins of the food or of the body.

It seems reasonable that when the food supplies too little protein for any length of time the formation of antibodies should fail and resistance to disease be impaired in consequence.

In immunology it is traditional that investigations develop into controversies between two schools. In this case one school has been led by Cannon who attaches great importance to deficiency of protein and consequent failure to form antibodies in lowering resistance to disease. He and his colleagues have kept rabbits and rats for long periods on diets that supplied very little protein, and have found that these animals have formed less antibodies than were formed by control animals, in response to injections of bacteria and other substances; also that animals recovered their ability to form antibodies when they were given more protein.

Cannon's theory can certainly be criticised. For one thing, animals that formed little antibody were eating much less food than was eaten by the controls; they suffered from deficiency of calories as well as deficiency of protein; protein is not the only factor. In other experiments in which the depletion of protein has not been so extreme no difference has been found between the amounts of antibodies formed by the deficient and by control animals. When we come to human beings we find that the serum proteins are often not reduced even by malnutrition severe enough to cause famine oedema. And when serum proteins do fall it is the albumin fraction that falls; the globulin fraction, which contains antibodies, is usually little changed. Gell (1948), however, has found that Germans suffering from severe degrees of malnutrition did form less antibodies than were formed by well fed British soldiers. Malnutrition, if severe enough, may therefore lower *this* defence in human beings.

Certainly protein is not the only nutrient that is involved in the formation of antibodies. Experiments have shown that the amounts of antibodies formed by pyridoxin deficient rats in response to injections were less than formed by control rats. The effects of diet on formation of antibodies by animals has a practical importance in testing the efficiency of the antigens used for immunising against diphtheria. Hartley found that guinea pigs formed more antitoxin on a cabbage diet than on a mangold diet. The chief difference in these two diets would be in the amounts of vitamin A. Observers, using different diets, would draw different conclusions about the efficiency of an antigen.

Further Lines of Defence

Cannon's school found that even when the deficient rats formed as much antibody as was formed by controls, more of the deficient rats died when infected by virulent organisms. In the control animals the number of leucocytes in the blood was trebled after infection; in the deficient animals the number did not rise. The effect of less severe deficiency on this line of defence and on the activity of other scavenger cells needs further study.

Increased Resistance

The few instances in which it has been claimed that resistance to bacterial infections is increased in malnourished animals are unconvincing. The fullest studies have been made on the effect of deficiency of vitamin B_1 on infection of mice with the virus of poliomyelitis. It seems that the chief effect of deficiency is to delay the onset of disease. In an infection by a protozoon—bird malaria—in which the organism can be watched, it is found that the numbers of parasites that invade the red blood corpuscles of chicks is less if the chicks are deprived of riboflavin than if they have a normal diet. In spite of the lower invasion rate more of the riboflavin deficient chicks die. It is significant that in these infections in which the effects are, for a time at least, less severe in malnourished animals the infecting organism enters and lives in the cells of the host. The difference between the effects in well and ill-nourished animals lies in the extent or rate of invasion of the host's cells. The organisms are very susceptible to differences of environment. Unlike bacteria they cannot grow in ordinary culture media and can only multiply in cells of certain animals. It may be that vitamin deficiencies so alter the metabolism of the host's cells that they are no longer congenial to the invader.

(*Paper read to the Physiology Section of the Association at the Annual Meeting in* 1948.)

EDUCATION

TOPICAL PROBLEMS DISCUSSED BY THE BRITISH ASSOCIATION

DURING the Annual Meeting of the Association at Brighton in 1948 the Education Section met, under the Presidency of Mr. W. O. Lester Smith, in the Training College. Though somewhat distant from the main body of the meeting the Section was appropriately and well housed and the varied programme was followed by large and distinguished audiences. If the tenor of the whole meeting was one of cautious optimism, the sessions of the Education Section were marked by critical and friendly analysis of a wide range of current problems and most of the papers were notable for constructive criticism.

The meetings of the Section were well and fully reported in the educational journals, particularly *Education*, *The Schoolmaster* and *The Times Educational Supplement*, to which acknowledgment is made by the editor of the following notes of the proceedings.

ASPECTS OF WORLD EDUCATION

The first morning Session (September 9) was devoted to consideration of some aspects of world education. The main papers dealt with the scope and functions of Unesco, and with education of British families in Germany.

Dr. W. P. Alexander and Mr. Ronald Gould opened the discussion on Unesco. Both speakers had first-hand knowledge of their subject, having been delegates to the Mexico Conference, and both were frankly critical.

Dr. Alexander considered first the question to what extent it was possible for Unesco to undertake work directly in the various educational fields. 'As I see it,' he said, 'Unesco has tried to operate on too wide a programme, involving too much direct action from Paris. Clearly, until national instruments are developed in every nation which bring together those concerned with particular aspects of education there is no real basis on which to bring the nations together to discuss their common problems. For example, in the field of adult education in this country there is a National Foundation which is representative of all interests, and therefore provides a means of communication with other nations on adult education. If this instrument were developed in a form appropriate to each nation, then clearly there is a basis on which Unesco could bring together interests in adult education throughout the world.

'I, therefore take the view that in the early stages of its development Unesco as a central headquarters should be limited in size and in scope, while the nations should devote some money to the development of national bodies or instruments which would be effective in their own nation in the fulfilment of the purposes for which Unesco stands.

'The functions of Unesco itself seem to me in these early years to be fundamentally twofold. First, to act as a clearing house for information. Second, to stimulate and encourage national activities and the forging of national instruments which are a means of fulfilment of Unesco's purposes in the nations. It seems to me that this would involve quite a substantial review both of the programme of Unesco and the constitution and organisation of the permanent personnel. As a body concerned to release energy in the nations, stimulate activity at national level and exchange information, the need clearly in Unesco House would be for a limited staff on a high level; a staff, too, spending as little time as possible on administrative mechanics and the maximum time and energy on field work. In a word, it seems to me that Unesco has to make effective the principle that it achieves its purposes through national activity, that it freely promotes and encourages direct contact between the various national instruments or bodies and itself acts as a general clearing house of information, including advice as to the appropriate national instruments in any country for these purposes.

'It should be noted that there is a necessary limitation on what can be properly achieved by an association of governments, which Unesco necessarily is. It follows that there must be a free development of national instruments which are expressive of educational opinion independently of governments if, in fact, freedom is to be retained in the realms of education, science and culture. I would therefore expect substantial development of international organisations among teachers and others, which would be officially outside Unesco, but which would in fact greatly contribute to its purposes and would collaborate fully with it.'

Mr. Gould followed with an acute analysis of the situation, and made some concrete proposals which were generally approved by the audience.

He mentioned his close connection with the Organisation and the fact that he was chairman of the Bureau for Exchanges and Visists, and emphasised that his criticisms were intended to strengthen and not to weaken it. To be more effective there must be three main changes :

(1) Unesco's purpose should be made much more clear.
(2) Its machinery should be streamlined.
(3) Its work should be limited to worthwhile projects.

The purpose of Unesco was to advance the objectives of international peace and the common welfare of mankind. The tools it must use were education, science, and culture, since its concern was with ideas and their impact on the mind of man.

' In pre-war days when the International Institute of Intellectual Co-operation in Paris, and what are often called " intellectuals, discussed developments in scientific and philosophical thought, excellent work was often done, but Unesco's purpose is much wider. The constitution speaks broadly of the " minds of *men*," of the " wide diffusion of culture," and declares that the various States are determined " to develop and increase the means of communication between their peoples." Unesco, then, is intended to be a popular movement. There is room for the scientist, the poet, the professional educator, the philosopher, but it must on no account overlook the " common man." This conception of the purpose of Unesco will shape its work. It must concern itself not only with the Hylean Amazon, with the flora and fauna of the Galapagos Islands, but with ideas at the box office and popular press level, with the organisations which influence mass opinion, the press, radio, and cinema. It is fatally easy for Unesco to concern itself largely with an intellectual élite. The man in the street has probably heard little or nothing so far of Unesco, yet its purpose is to serve him.'

As regards the machinery of Unesco Mr. Gould suggested that conferences were held too frequently, and at places too distant from Paris. Too many conferences and too many long journeys were not only a waste of time, but hampered the work of the Secretariat. ' The conference at Mexico City lasted three and a half weeks. From Paris by land and sea, the journey to Mexico City takes about nine or ten days. Every member of the Secretariat attending must, therefore, have been away from Paris for at least six weeks. Can so much time be afforded ? Add to this the work of preparing for Conference and clearing up afterwards, and it is clear that there is little time left in the year for constructive effort. Moreover, a programme which looks forward for no more than a year gradually makes long-term planning impossible. A conference which provides a programme for at least three years would make for less wasted effort and much greater efficiency.'

Speaking of the projects of Unesco Mr. Gould said, ' One of the earliest errors, and one which has caused confusion amongst many, was the advocacy that Unesco should produce a universal educational philosophy. Such a philosophy, it was argued, would advance the objective of universal peace and the common welfare of mankind.

Mr. Gould said he knew of no philosophy which could satisfy both Christians and Materialists. ' This philosophic Esperanto, this synthetic religion, is a dangerous illusion. Its advocacy produced division and aroused opposition from all quarters. On such a basis co-operation and collaboration is impossible. The fullest co-operation can only be secured on a programme of practical projects.'

Mr. Gould concluded with a plea that Unesco should be regarded as the friend and ally of educators everywhere, and his audience warmly endorsed his belief that Unesco would become one of the most potent instruments for raising standards in education.

The papers by Dr. Alexander and Mr. Gould were followed by general discussion in which Sir Fred Clarke, Dr. Maxwell Garnett, Mrs. E. V. Parker, and others took part.

Education of British Children in Germany

Mr. John Trevelyan then read a paper on the British Families Education Service (B.F.E.S.). He said that the problem which faced its organisers was that of educating some thousands of British children living with their parents in small communities scattered over an area as large as England and Wales. Complicating factors were widespread war devastation that existed in Germany, the fact that their rations were higher than those of the surrounding population, the fact that they had no roots in the country, and lastly the fact that they were the successful contestants in a frightful war occupying the land of their defeated enemies.

The aim of the B.F.E.S. had been to conform as far as possible to the principles of the Education Act of 1944. A start was made with primary schools for which private houses, hotels and barrack buildings were used. The first school was opened in December 1946.

Secondary education came next, and it was decided that this must be in boarding schools,

except in Berlin and Hamburg, where the numbers were sufficient to warrant day schools. By careful publicity, including broadcasts, the parents were shown that in these boarding schools their children would have educational opportunities that many would not have at home. The demand was assessed at more than 90 per cent. of the possible.

To make a success of these schools it was important to get the use of really satisfactory buildings. This presented considerable difficulties, since the best buildings were already in use for other purposes. The Navy, however, released the Marine Barracks at Wilhelmshaven, which included some of the finest buildings in Germany. This school was called Prince Rupert School, Wilhemshaven, and was opened on July 1, 1947, with 75 children, all over 14, and tested the organisation for a four-week summer term : the school re-opened after the summer holidays as a full school of 245 children of 11 to 18.

In the British schools in Germany experience was being gained of ' the common school.' No distinctions were made : the child of the ' Other Rank ' parent working side by side with the child of the Senior Officer. ' When visiting schools, I frequently ask whether differences of parents' rank or position have produced problems, but I have never yet been told of difficulties arising in the school from this cause, although such differences can cause problems in parent-teacher associations.

' The problem of class distinction in education is one to which we are all striving to find a solution, and it may be that our experience in this unusual situation in German will point the way to future solutions on a wider scale.'

The decision to have co-educational boarding schools was not taken primarily on educational principles, but with a view to making the schools more readily accessible to parents than single-sex schools would be. ' The relationship of boys and girls is easy and natural as soon as the novelty wears off—and it wears off rapidly. The policy has been adopted of segregating the sexes as little as possible, while providing every possible opportunity for boys and girls to take part in school activities together. The houses at both schools are mixed : boys occupy one floor and girls the other. There are Common Rooms shared by both sexes and also separate Common Rooms for boys and girls, since it is found that at times each sex prefers its own company. We have not yet fully explored the possibilities of co-education, but from our experience so far we feel that we may discover in it very definite educational opportunities.'

Mr. Trevelyan concluded his description of the B.F.E.S. by describing the relationship between British and German children, and how British children learn the German language.

Administrator and Teacher

The second day opened with the Presidential Address by Mr. Lester Smith on ' The Changing Scope of Education,' which has already been published in full in *The Advancement of Science* (October 1948). His address followed by a discussion on ' Administration and Teacher and it is appropriate therefore to include here some of the things he had to say on this subject.

Himself an administrator in education he expressed great concern about the increasing amount of administrative work being thrust upon head teachers. ' It began,' he said, ' in the public schools because of their early emphasis on corporate activities and the total education of each individual pupil. Most of the grammar schools established under the 1902 Act, and of the primary and secondary schools now emancipated from the elementary school tradition have an active corporate life, ' and many are harassed by demands from which the public schools are immune.' The head teacher's function ' is changing rapidly as a result of the growth of corporate activities, the demands of society, and the aftermath of Government schemes.'

He presented the following analysis of the head teacher's managerial duties :—

(1) Arrangements for the numerous school activities ; (2) interviews ; (3) Government sponsored schemes, *e.g.*, national savings ; (4) projects such as adult centres, youth clubs, that the school must accommodate ; (5) other schemes, sponsored officially or by voluntary organisations ; (6) organisation of examinations, school records, and other scholastic devices ; (7) reception of sponsored visitors, including students for school practice ; (8) completion of questionnaires and filling up of forms ; (9) organisation of harvest camps, industrial and educational visits ; (10) local, regional, and national meetings, including refresher courses.

Some of these demands, he said, were necessary and desirable, and with the growth of special consciousness would no doubt expand. ' But some suggest the resurgence of the old law of subordination in a new guise. Demos behaving like the old feudalism writ large.' If the Education Act was to become a living force, there was need for constant creative thinking about the future of the primary and secondary schools ; and it was tragic that at this time for greatness their Heads were

unable to give their whole minds to their essential task.

'One of the most difficult issues to determine is the extent to which schools should respond to the claims which modern society makes upon them. They cannot to-day function in isolation, nor can teachers be "a race apart." There is, however, a limit to the sociability of schools, a plimsoll line at which service to the community becomes a danger to education.'

If a service rendered by a school fits naturally into the curriculum or corporate life, the pupils may gain useful and satisfying educative experience. If, on the contary, it is a marriage of convenience designed to further a Government scheme or one promoted by an importunate organisation, there can be waste of valuable teacher time without compensating advantage.

Discussion on 'Administrator and Teacher' was opened with a provocative paper by Mr. L. R. Buckley. He quoted from Matthew Arnold who wrote in 1862 :

'They are getting more and more troublesome, that is, more rigidly mechanical, at the Council Office, in laying down everything beforehand for the Inspectors, and in suffering no deviation from their rules.'

Thus early did the administrator of education receive his baptism of fire. But in 1862 the administrator, as we knew him to-day, had yet to come. As our national system of schooling developed it became the practice, for what could be called progressive Authorities, to appoint as executive officers to their Education Committees men who could claim, in addition to clerical ability, some knowledge of the actual business of education. Such men would base their claim on the possession of some academic qualification and a measure of teaching experience. This fashion, however, of translating the schoolmaster from ferule to filing cabinet did not meet with an immediate and general acceptance, and until quite recently there were Authorities who, with an unconscious prudence, which doubtless had its roots in parsimony, preferred a Clerk to a Director, and entrusted their office management to someone without academic status.

The Act of 1944, however, imposing uniformity where previously there had been discretion, made what had become fashionable obligatory. With it, the Education Officer was placed on the same footing as the Medical Officer of Health, and took rank, in the hierarchy of local government, with the Treasurer and the Chief Constable ; for not only was the Authority compelled, now, to appoint him, but the Minister had powers to prohibit the appointment 'if, in his opinion,' to quote the words of the Act, 'the candidate is not suitably qualified.' The Act did not venture to define the qualifications which were suitable for a Chief Education Officer. That was left to the Minister. To some, this would seem a wise forbearance. To others it would be yet another example of what Lord Hewart called the New Despotism.

To the administrator, then, the Act brought a new prestige. The day of the unregistered practitioner was ended and the Education Officer was confirmed in his professional status. But if the Act was silent upon his qualifications, it was equally silent upon his functions. It made no mention of what his duties were to be. He was, of course, to be no Ornamental Hermit, gracing without toil the new scholastic Eden, for it is clear, if only by implication, that his duties must, in part, be executive. It was, however, equally clear that Parliament intended them to be something much more than that. During the passage of the Act it was stressed that the Education Officer must now be able by attainment and experience, to give sound advice to his Committee on the matters that come before it.

While, then, in theory, the administrator held no controlling powers in fee simple, in practice his potentialities to that end were considerable. For education to-day was a complicated affair ; and when his Committee was saddled, as Education Committees were to-day, with the task of implementing a Bill whose provisions ranged from truancy to trade courses, from catering to county colleges, it was almost inevitable that real power should pass more and more from the Committee into the hands of the Permanent Official. He was the expert appointed to advise them ; and respect for the expert is part of our English discipline.

Possibly no section of the new legislation has been implemented with quite such energy as that which empowered Counties to set up Divisional Executives. We read, indeed, of one Authority which is now in the process of reducing the number of its Executives, having divided itself, in an excess of bifurcation, into rather more than twice as many administrative areas for education as it had for its health and fire services. But if an enlarged administrative machine enhances the prestige of the Chief Education Officer, the lot of his Divisional Assistant is a less happy one, for the Executive has the semblance of power without its substance, being forbidden to levy a rate or raise a loan. Moreover, the Director is often unwilling to delegate his own authority, even in matters of routine, so that the Divisional Officer can do little more than echo the decisions of his Central Office ; and, since he is human, and

ambitious, he dissembles his redundancy, seeking to justify his existence in a repetition of memoranda and returns. For it is a commonplace of the bureaucracy that it magnifies the trivial and makes a necessity of the unimportant.

But if the Divisional Officer owes his authority to the indulgence of his superior, both, nowadays, must acknowledge increasing control to the Minister. Parliamentary Office in Education is no longer a forcing ground for the statesman of promise, nor yet an asylum for the politician whose influence is greater than his efficiency. The Ministry is a new creation and has a new political glamour. It has, too, new functions. We no longer have a President, nodding approval to local initiative through the windows of his empty Board-room. He has given place to a Minister who has himself initiative, and whose duty it is to promote education.

We have, then, a trio of administrators—the Minister seated firmly at the first desk, at the second the County Officer, playing with all the rubato which the score will allow, and at the third his Divisional Assistant, performing industrious if ineffectual arpeggios. To these we must add a fourth—the new Headmaster. His claim to be an administrator is of perhaps doubtful validity, for as the notes of the other three sound ever more insistent in his ear, he can do little more than repeat, in a lower register, what they have stated.

But if a preoccupation with the organisation rather than the content of education distinguishes the administrator from the teacher, then it is true to say that the new headmaster approximates more closely to the former. In the past, things were different. The best headmaster was primarily, like his staff, a teacher. His first concern was to know his pupils, and since he could know them best by teaching them, he was to be found more often at the blackboard than in the office chair. His qualities sprang from scholarship and a love of teaching, and though he might be building a great and enduring institution he looked upon every task which kept him from contact with his pupils as an interruption to be surmounted with all dispatch.

If the history of English Education is a record of great headmasters it is, in part, because those headmasters never forgot that organisation is not an end in itself, but only a means to efficient teaching. The headmaster to-day is not so much scholar as steward, not so much teacher as typist. He is, in fact, a Clerk of the Works, the representative in the school of the County Office. And as his clerical duties increase, the individual pupil becomes less and less a personality to him, and more and more what he is always to the administrator—a record card.

Amid this galaxy of administrative prestige, amid, too, a plethora of organisers and advisers on every facet of education from Folk Dancing to Forestry, the ordinary teacher in the class-room may be forgiven if he feels rather like the private in some Ruritanian army where everyone else is a general. It is certain that as the administrator grows in importance the teacher's standing, which was never high, subsides. For, compared with the others, he begins at a disadvantage. Unlike them, he does not enjoy the status of an expert, for no one is considered an expert on the class-room until he has left it. Teachers may talk boldly of their calling as a profession, and teachers' organisations may believe that their efforts have made the usher a figure of the past, but they convince few beside themselves. The simple fact remains that there is a great gulf between the status of the teacher and that, for instance, of the doctor or the lawyer.

Mr. Buckley said that when the new Act required Local Authorities to submit development plans it made the administrator the architect of the new education, for the preparation of those plans fell largely to him. He was the arbiter of the future. Administrative convenience, however, and efficiency in the schools did not necessarily coincide, and as development plans took shape tendencies were revealed which gave grounds for apprehension. The first was the propensity of the administrator to centralisation. The school commonly found itself compelled to submit its order for anything which it wanted to a distant and perhaps overworked official, for when the administrator was in power it was his principle that every requirement should come to him for approval or review. Such a system not only robbed the school of local contacts which might have value far beyond their immediate use. It deprived the school of a measure of self-determination.

It was a heritage, often, from ancient foundation that gave to the State Grammar School a greater degree of independence than had other schools. Its claim to self-determination might be seen in the standards which it demanded from its pupils. It demanded from them a code of behaviour and, perhaps, of dress, and participation in its games and activities ; and these standards, however arbitrary they might seem to an outsider, gave the school its individual character. It is true that the parents of its poorer scholars had often to make sacrifices to conform with its traditions, but they were sacrifices which impressed upon both parents and pupils the value of the education which the

school provided. And, in the main, the freedom of the Grammar School was justified by its achievements ; for not only had it wrested from the Public Schools their monopoly of university awards, but it ensured that every generation should include men girded to high purpose.

When, therefore, the principle was established that there should be parity in schools, it was to be expected that we should effect it by extending gradually to other schools the privileges of the Grammar School, and by encouraging them to assume its responsibilities and to emulate its standards. The wind was set favourably in that direction ; for already schools of lesser standing, like the Central School, had shown themselves able, given the opportunity, to achieve its status. In practice, the reverse is happening. The administrator levels down, not up. To him, parity means the application to the Grammar School of a tighter administrative control, the extension to it of regulations previously more honoured in the breach than the observance. For the Grammar School, where it saw expediency, followed the English tradition of freedom, that everything is allowed which is not expressly forbidden ; but the administrator, in his concern for the letter of the regulation and in his anxiety that no parent shall make sacrifices or, it would sometimes seem, accept responsibilities, follows the principle that everything is forbidden which he has not expressly allowed.

There were many indications, from a rise in juvenile delinquency to a decline in handwriting, that education, or at least the type of education which we had known, was not what it was. And if the administrator claimed to direct education, he must share the responsibility for its shortcomings. For his control was not confined to externals. Directly and indirectly he now exercised considerable influence both upon the curriculum and upon the way in which it was pursued.

The administrator had to deal with large numbers—with children not as individuals, but in the mass. He needed methods, simple and convenient, by which to classify them. The psychologist purported to provide the methods ; and the administrator, without the yardstick of current class-room experience was prone to accept them. Lately, the psychologist had been the target for many barbs ; but however lightly or severely we criticised him we must agree that his science was as yet immature. It was, then, a matter for serious consideration whether we could continue to let the whole child-population of this country serve as guinea-pigs for what Professor Sir Cyril Burt, at his most defiant, could call no more than ' an important and well-considered experiment.'

Mr. Buckley said that in this country we were happily free from what, elsewhere, had been the greatest danger when the control of education had lain outside the school. Our schools had not become a medium for political propaganda nor was it likely that they would. Yet, on a more innocuous plane, the possibility that schools might be diverted or distracted from their proper purpose was apparent. For the administrator, whether Minister or County Officer, was one of a team who covered every phase of government ; and harmony or co-operation within the team made it natural for the controller of education to put his organisation at the disposal of the others. It might be necessary and even desirable that in times of emergency schools should be employed to promote the national economy—to issue Savings Stamps or to collect rose hips ; but when we heard that one Authority was to teach its children to read the gas meters as part of a campaign for saving fuel, it might be as well to remember Lord Macaulay's warning—that a gas company which should also be an infant school society would light the streets ill and teach the children ill.

These, then, were the dangers of administrative control : that the growth of the administrator's prestige was at the expense of the teacher, and that efficiency in the schools was subordinated to his convenience ; that centralisation destroyed individuality and discounted tradition ; that the administrator misrepresented the policy of parity and reduced rather than raised standards ; that he controlled not only the organisation but also the content of education, and that he was credulous in his acceptance of theory ; that his concern with public relations brought to education an unwelcome exhibitionism ; and that, while he ruled, quantity must count more than quality.

The headmaster must again become the first of his teachers. His concern must be for the quality of education in his school, and administrative demands upon him must be subordinated to that end. And since the headmaster could not teach if he must spend his time referring and reporting every detail of his management to the County Office, our whole conception of administration must be modified. Its aim must be to extend rather than to curtail the freedom of the individual school. And if the administrator of education was to share in the framing of policy, it must be because he remained a teacher. If he were to take a sabbatical year in a return to teaching, he would not only win a new respect from the teachers, convincing them that his interest was in education, not in its control but he would gain a new ability. For it was only in the class-room that he could see

theories in their true perspective. It was only in the class-room that he could glimpse with youth the vision splendid and learn the quickening challenge of his charge. The child could never be fully represented by statistics. That was why the administrator must return, at times, to teaching. For education, unless it be for robots, must be shaped not by men who think of children in categories, but by those who know them as individuals.

Sir Fred Clarke was the second speaker and said he thought that Mr. Buckley had failed to recognise the situation in which administrators now had to work. A comprehensive Education Act had imposed a heavy burden of responsibilities upon Local Authorities and their administrative officers, and he would therefore discuss the relations between administrators and teachers in the light of the Act's provisions. He continued :

For most of us here the liberty that Mr. Buckley takes by implication is neither desired nor possible. We have the intention, many of us the specific duty, of obeying the law, that is to say, to do whatever we can to make actual the rich promise of educational legislation unprecedented in the universality of its scope and in the generous humanity of its inspiration. So my contribution takes the form, not so much of a defence of the administrator as such, as of an attempt to survey the situation in which we have all alike to work ; to show that the task before us is in large measure inevitably one for administration, and to suggest that administration could and should proceed upon a principle upon which we can all unite. I shall go further and suggest that the right principle is already being discovered and acted upon, with a promise not only of preserving the valuable elements in our tradition but also of extending their blessings to some millions of our young countrymen who have not had their fair share of them in the past.

No one who has tried to take the measure of such a task will have any doubt of its magnitude or of the grave risks involved in the discharge of it. If we are to carry it out successfully we shall have to change our ways. In particular, two demands will be made upon us, the meeting of which will involve much searching of heart and some creaking of brains. These are demands, first, for systematic study, and, second, for coherent rational thinking.

It is a continuous reproach to a people so placed as we now are that, in spite of much recent improvement, the need for systematic study of our educational necessities should still be so gravely underestimated. Under the requirements of the Act we have now to face and reduce to some rational and workable order a vast complex of multitudinous *facts*. If this is not a task for administration, then I don't know what administration is for. Indeed, for some time a few of us have been busy creating unofficial or semi-official organisations to assist the administrator in the gathering and interpretation of the facts in certain important fields.

If this demand for systematic study is not effectively met the administrative effort must fail. If if does fail, the chief sufferers will be the teachers in the schools, including those who are now most vocal in denunciation of the administrator. With such a task before us *we must know where we are going*, and, for that, comprehensive command of the facts is essential.

In the second place, we shall have to learn to *think* coherently and rationally about our problems in the light of the facts. It will no longer be enough to rely upon the practical ' hunch ' or the tip from tradition, or, still worse, to dress up some cherished prejudice so that it might look like a respectable educational principle. To a people of tradition hitherto, in their happy state, needing so little to think about their affairs with a comprehensive rational coherence, this may be the severest test of all.

I can now state the principle upon the basis of which I believe we could secure clear-sighted co-operation by all concerned. It can be quite simply as the autonomy of the school. There is nothing new in the principle itself, for it has come down to us from the long tradition of university, public school and grammar school. What is new, almost terrifyingly so, is the challenge to give effect to the principle in a publicly provided system of schools designed to cover the whole child population of the country up to at least the age of fifteen.

I am fortunate in numbering among my friends a good many of the Education Officers of the localities. I know them well enough to assert with confidence that the great majority would accept the principle I have enunciated as that which inspires their planning and action. That is why they are so much concerned about teachers, realising as they must that teachers constitute the first, if not the chief, defence line of school autonomy. If teachers generally can define accurately and adequately the educational challenge that is put to them by their schools, so diverse in situation and possibility, and then meet the challenge with all the resources at their command, the task of administration is immensely simplified. It becomes very largely one of wise selection and judicious placing of teachers, and then a concentration of effort to ensure that teachers have all possible resources with which to meet their professional

challenge. In this connection it should be noted by the critics that the title, ' Director of Education,' that was formerly applied to the chief local administrator, has now been quietly dropped. It is to be noted, too, that it is not only teachers who have the function of guardians of the free growth of children in a well-supplied and well-protected school situation. The function is shared also by administrators, by Local Authorities, and by the Minister himself. The Act makes that clear enough. So it is upon firm acceptance by all concerned of a clear practical definition of this function that the proper discharge of the administrative duty depends. I submit that the phrase ' autonomy of the school ' affords a sufficient clue to such definition.

Strong as is the tradition of autonomy in what may be called the upper levels of English education, it has been badly broken into in the past at the lower or elementary level. So we have the task not only of extending the play of a great tradition into new and wider ranges, we have also to eradicate from our thought and action the still continuing influence of a very bad tradition. In the effort to do so administrators are achieving more success than are some influential sections of rather vocal opinion. Indeed, it would sometimes appear that it is the very success of the administrators in this matter which is the ground of the censure.

I must add in this connection that we overlook a critical turning point in our educational history if we over-emphasise 1902. The decisive year was 1904, the year in which there appeared an official publication from the Board of Education entitled *Suggestions to Teachers and others concerned in the work of Public Elementary Schools.*' The essence of the decision is conveyed in that one word ' Suggestions ' ; the whole principle of autonomy is implied in it. So, in that respect at least, the Act of 1944 is not so novel after all, even where the schools that used to be ' elementary ' are concerned.

Having now enunciated a central principle of policy, which I hope finds general acceptance, I come to the heart of the challenge that faces us. *Can we do it ?* Can we in these new and difficult conditions, preserve throughout the principle of autonomy and still get the results we hope for ? Don't let us be over-optimistic about that, for the difficulties are going to be immense. Yet is there any people on earth upon whom it is more incumbent to make the effort ?

Failure will involve us all, critics and advocates alike, and not the least of the reasons for averting failure would be the shame of it.

One guarantee against failure would be to reach a just estimate of the difficulties. So let us take a brief glance at the conditions in which we have to make the effort.

We note first that we are in a grim economic situation, with the certainty that the presuppositions of the national economy have changed fundamentally and very largely to our disadvantage. So we turn with increased concern to our chief national asset, the intelligence, integrity and potential skill of our people. We can afford now to neglect none of them or to miss the cultivation of any latent ability among them. So education has now the task not only of developing free intelligence, cultivating adaptability and conveying a diversified body of necessary and usable knowledge, it has also to undertake the task of a preliminary ' sorting ' of the whole child population as so to ensure that each receives the education which is at once most fruitful to him personally and of most value to a necessitous nation. Is it to be supposed that this can be done without a great deal of anxious administrative planning and oversight ?

There is another aspect of this new situation of ours which most vitally concerns the school and requires above all things that the school's autonomy be preserved. As a nation we have to keep ourselves *efficient* in respect of all the demands that this difficult contemporary world will make upon us. At the same time I assume that we are resolved to remain *free*. Such a marriage of efficiency with freedom cannot be maintained in the nation at large unless it is first effected in the minds and characters of individual citizens.

Again we are living in the midst of a powerful urge, that will not be gainsaid, towards greater social equality. Now, if what is regarded as social justice is to be a main criterion of policy, honestly applied, then to ensure its reality there will have to be checks and tests and controls of many kinds. These will have to be administered, and that means bureaucracy. Mr. Buckley is right in saying that bureaucracy needs to be watched. Nevertheless it is indispensable to social justice, and if you are not prepared to will the means you must repudiate the end.

There is evidence enough that a highly complex technological society such as we have now, breeds its own dangerous tendencies, which have to be checked. In particular it makes for autocracy at the top and dehumanising in the mass, together with some dilution and corruption of culture. The true checks are to be found only in the inner life and conscience of the cultivated citizen.

These contemporary conditions, and others that could be cited, serve to emphasise how grave and how responsible is the task set to the ordinary school. Think of the qualities that we shall now have to set ourselves to

induce in the individual citizen : the critical intelligence, the restraint and tolerance, the sense of responsibility and capacity for self-discipline, the level of taste, and, above all, the integrity of conscience. Only a school that is well-manned and well-equipped, and at the same time both responsible and free, can play its proper part. We can indeed agree that administrators need to be watched lest they encroach upon or obstruct this all-important function of the school. But if, as I hope and believe, it is precisely this function that most administrators recognise, and regard themselves as serving its needs with all their powers, then there is so much the less to worry about. If the administrator does his duty it is for the teacher to do his.

What are the sources of possible danger in this matter of administration? There are two of them, one of which we hear much, another of which we hear less. The first is that of an excess of rigidity and dictatorialness in official action. Here I must say that with some knowledge of the facts I do not recognise the terrifying picture that Mr. Buckley draws. I go about the country a good deal to teachers' meetings and refresher courses and must have met thus some thousands of teachers. Nothing has impressed me more than the close and friendly relations that subsist between teachers and education officers, and I would add between teachers and His Majesty's Inspectors, all working out together those problems set by the Education Act.

The second source of danger, though less obvious, is still serious. It consists, in a word, in the spirit of anarchy, the temper which denounces autocracy outside the school in order to remain autocrat within it. This is not what *I* mean by the autonomy of the school. Such a temper, if it became widespread, would, in the long run and in present conditions, be fatal to the persistence of any autonomy at all. In its own way it is at least as dangerous as its opposite, the attitude, now so much less common, which says in effect : 'Tell me what to do and I'll do it.'

To any possible autonomy of the school there are two kinds of limit. One is the limit of available resources, counting among these the quality of the pupils. The other is the limit set by the function of the particular school in relation to the total national purpose. No school, at any rate no school within the public system, has an exclusive right to say what the function should be, still less to stand apart in complete self-determination.

The problem may thus be stated as one of finding the middle way between this kind of anarchism and the excess of rigidity already mentioned. It is here that well-informed criticism can be so helpful. The continued existence of schools entirely outside the publicly provided system should in my view also prove helpful. If they are good and efficient, their very existence helps to set standards of criticism. If they go further and actively criticise, that, too, may be helpful, provided they do justice to the declared national purpose and resist any temptation to become pharisaical. Also they should remember how closely their freedom is involved in the achieving and maintaining of a satisfactory provision of the people at large.

I conclude, then, that having before us the vast programme of action that the Act lays down, and, taking full account both of the principle by which the programme is inspired and of the extremely difficult conditions in which we have to carry it into effect, there is an inescapable task for efficient and rightly inspired administration to do. I hope I am not wrong in saying that it may be described as the duty of putting the teacher in the most favourable position to do what only the teacher can do. I see no inherent reason why there should be any major conflict at all, though there will always be minor ones on points of detail or as arising from mistakes and indiscretions one way or another. It will help much if the teacher's share of the purely administrative burden can be kept at a minimum, only so much as is inseparable from the part the school must play in the total national effort.

In the discussion which followed the papers by Mr. Buckley and Sir Fred Clarke, the speakers included Dr. P. F. R. Venables, Mr. A. Grey Jones and Mr. Walsh.

The Young Worker in Industry

The third session in the Section's programme (September 13) opened with papers on the Young Worker in Industry. The first paper was by Mr. Kenneth R. Evans in collaboration with Sir Arthur Fleming. This paper consisted of a comprehensive and detailed sketch of the existing situation, together with an enlightened and sustained argument for a general and far-reaching attack on the problem, for the benefit both of industry and the young people concerned.

After pointing to the relationship between a society's standard of living and the effort needed to maintain it, Mr. Evans stated his conviction that the complex manual and mental studies essential to modern industrial society must be founded on a sound general education. While in a primitive society the individual could see that his own standard of life depended on his own skill and energy, in modern civilisation the connection, so far as

the individual is concerned, is by no means so obvious.

He showed that exhortations to work harder were not enough. Effort in itself is not sufficient. It must be intelligently trained and directed. This led to a consideration of the need for utilising the abilities and aptitudes of various individuals, and hence to the assertion that if children were wrongly selected for a type of secondary education at eleven plus, no considerations of administrative convenience should interfere with its correction.

Those responsible for training in industry and commerce could play a great part by careful planning of their training schemes, so that the young people are directed into channels for which they are most suited. Vocational guidance should be a continuous process; it should not just begin and end at the school-leaving age, but should be maintained as long as the individual boy showed developing aptitudes.

The paper reviewed industry's contribution to education through its works' schools, and indicated that some of the experience gained in these schools might be relevant to the county colleges of the future. It described the steady development of apprentice training schemes with particular reference to the more technical industries such as engineering. Reference was made to part-time day release for technical and general education which was being granted by an increasing number of firms to their young employees.

The modern tendency to plan apprentice training at a regional and national level was discussed, as were the training problems experienced by the smaller firms. Large firms could provide courses of a high standard, leading up to professional status, which were beyond the power of small firms. On the other hand, in the smaller firms a personal contact was possible, the absence of which was sometimes a disadvantage in the larger units.

Mr. Evans showed the value of releasing young student-workers for visiting and studying works in other places, and he specially commended the suggestion that young men trained to be professional engineers should be released by their firms to gain wider experience, not only in this country, but also overseas. The value of international exchange of trainees in cementing political and economic unions between countries was emphasised as is the need for this country to maintain and extend the reputation for sound training which is being built up in many industries.

Mr. F. Bray's paper examined the effect of further education schemes and discussed ways in which the country's educational system could help to remedy their defects. He said that between 30 and 40 per cent. of school-leavers were receiving some form of further education. But the other 60 or 70 per cent. were a serious problem to which pale faces and loss of personality (the results of overwork) among pupils in evening classes bore witness.

There was no single remedy. Employers could not be compelled to provide general education for their young workers; some could not even arrange for their technical training. But industry had some responsibility for general education. Some hundreds of education officers had been appointed in the last few years, though they were mainly confined to large firms. Most small firms had no education or training officer.

In Sweden young people spent two or three years in State colleges before entering industry. The training of a Swedish tailor, for example, took four or (for one who showed aptitude for advanced training) six years—*i.e.* as long as the training of a doctor in Britain. The county colleges could also help. Their great advantage was that they provided general education for the vast numbers who must inevitably go into unskilled occupations, but they were also for the craftsman. One day a week, however, could scarcely meet a youngster's technical needs completely, so if industry expected the county colleges to provide training which was properly industry's responsibility, then industry would have to be prepared to release employees for more than one day a week.

The function of the Government was to train officers who would have the knowledge both of young people's needs and of industrial conditions, and who would be able to meet the educational needs of the pupils and at the same time to satisfy industry.

Mr. Bray made a telling plea for the industrial training of school leavers, a large proportion of whom, good material when they left school, speedily lost much of their quality for lack of someone to enlist their interest and carry on their education.

The Ministry of Education were now experimenting in training special teachers for the 15–18 groups. Three technical teacher-training colleges had already been set up. There was also a system, recently introduced, of university scholarships for part-time students—150 applicants in 1947 and 300 in 1948.

Mr. Bray concluded with a tribute to the teachers who often worked voluntarily and to the firms which released their specialists to give voluntary lessons to young workers.

In the discussion that followed the speakers included Dr. Venables and Mr. W. Griffith. Mr. Griffith emphasised the advisability of

making the standards of the county colleges so good and attractive that the young people would not limit their attendance to the compulsory sessions.

Research in Universities

The morning session on September 13 closed with a paper by Dr. A. F. H. Ward on research in Universities and Technical Colleges.

He said that the subject was of fundamental importance because most advances in science come from the researches conducted in the universities. His main purpose was to discuss the practical problems of research workers in universities and technical colleges, to consider what difficulties obstruct them and limit the output of research work and to suggest how these might be overcome.

These institutions of higher education, he said, should provide a main source of the new scientific ideas and technical developments which alone can preserve this country. Research work is necessary to keep the teaching staff up to date and to train students who will go into development work in industry. But there is difficulty in obtaining suitable staff, interested in research, since University and Burnham scale salaries compare so unfavourably with those in industry where there are many excellent openings for research. Teaching programmes in technical colleges are usually so heavy as to limit the opportunities for research. The supply of research students is too frequently curtailed through lack of adequate financial grants.

The small institution is necessarily handicapped, because of the various subsidiary services which are essential, such as library, workshop and instrument maker, glass-blower, and a supply of the more expensive pieces of apparatus which may be required for special measurements from time to time. For a small college the resulting overhead cost may be prohibitive. Similarly, in a small institution there are few opportunities for discussions and the exchange of advice between colleagues with experiences in different specialised fields ; and discussion is one of the most potent generators of new ideas.

Dr. Ward emphasised that the facilities for publication of research work must be improved. The present restriction on paper supplies caused long delays and when delay reached two years, as was not unusual, the research worker felt that it was hardly worth while to write up his work.

The session closed with a few remarks from Sir Arthur Fleming, who urged that there should be a close understanding in all stages of education from the nursery school upwards with regard to the curriculum between the desire for a rising standard of life and the amount of work done. The latent ability of our young people is an enormous natural resource which needs development by industrialists and scientists, and care on the part of the nation's leaders. The all-important factor in research is the human element.

Reconstruction of Education in Germany

During the section's only afternoon session of the week (September 13) Mr. R. Birley, then Educational Adviser to the British Military Governor in Germany described the British experiment in German education, an experiment which was probably unique in history.

He said : I do not know whether it has ever before been the avowed intention of an occupying power to try to alter the characteristics of a defeated nation by influencing its educational system. Perhaps we ought to recall the Wars of Religion in the sixteenth and seventeenth centuries. Certainly we must not forget that the Germans during the war itself, while they occupied large parts of Europe, did exactly the opposite, that is they attempted to destroy the educational systems of other nations as part of a design to turn them into helpless subject peoples. This is of some significance. The attempt by the Germans to destroy the educational systems of other nations, as much as the attempt by the Allies to reconstruct and alter that of the Germans, was a tribute to the position which Education has gained during the last century. The provision of Education has become, of course, a normal function of Government, and this itself made it inevitable that the four occupying powers should exercise control over the educational system of a defeated nation left without any government at all. But beyond this lies the fact that it is now taken as axiomatic that Education, because it has become compulsory and a service provided by the State, can play a vital part in determining the character and so the policy of a nation.

Only someone who was very ignorant or very conceited or quite blinded by passion would try to belittle the greatness of German Education in the nineteenth century : yet looking at the recent history of Germany, it must be admitted that German education has been a tremendous failure. There are two main reasons why it has failed and until we have understood these we cannot do much to help the reconstruction of German Education to-day.

First, in spite of its technical efficiency, it failed to do what is needed of Education in the modern world : it did not create an

instructed public opinion in society as a whole. Secondly, the Germany educational system had become in many ways out of alignment with the social conditions of the age. It is important not to exaggerate this phenomenon and it is certainly wrong for Englishmen to go too far in criticising it. Under the Weimar Republic a larger proportion of children went together to free primary schools than in this country. The German system of ' Further Education ' was, and is, ahead of our own. Moreover, education at Secondary Schools and at Universities in Germany is not expensive. On the other hand, not only was Secondary Education not free, but the provision of scholarships for the children of poor parents to Secondary Schools and Universities was very scanty. Largely as a result of this the Universities had become to a great extent something not far removed from vocational colleges for a limited number of professions, especially the civil service, and the Secondary Schools were regarded almost exclusively as institutions leading to the Universities. The whole process encouraged the overweighting of purely academic training in German Education. It did something else, which is more difficult to define, but perhaps even more important. It encouraged the idea that it was the business of Education, above all else, to produce tangible results, in the way of examinations successfully negotiated. I can perhaps best speak of this as the irrelevance of German education.

The work done by British Education Officers in Germany during the past three years has passed through two phases and it is now moving into a third. The first phase, which lasted until the end of 1946 was primarily a question of control and material reconstruction. The task of getting the school and Universities started again was one of very great difficulty. It was carried out mainly by the Germans themselves, but without the help and encouragement of the British Education Officers this physical reconstruction in the British Zone would have been impossible. The necessary co-operation with German teachers and education officials established relations between those of both countries working in this field, which has stood us in good stead ever since.

It made possible the task of the second phase. This second phase began on January 1, 1947. On this date Education, along with certain other subjects, was handed over to the governments of the four Lander or States (or, as they are usually called, Regions) of the British Zone. British Education Officers have still had to make sure that there were no specifically undesirable developments in German Universities or schools, but their main task was now to advise and assist the Germans through their personal relations with them and by bringing them in touch with the educational world beyond the frontiers of Germany.

Many people believe that we still control German Education, some that we actually teach in German schools, which we have never done. Also, those who are aware of what has happened are often critical of it. They feel that we handed over control of Education to the Germans too soon. This is an understandable point of view. It was a bold step. We went further than the Americans, and the French and the Russians did nothing of the kind. But I believe it was justified for three reasons.

First, it is no use supposing that the Germans can learn democracy without practising it. Secondly, Germany has only too often in the past had Freedom give to it from outside, ever since Napoleon broke up the ossified feudalism of the Holy Roman Empire at the beginning of the last century. A free society can only be based on the personal agonies of individuals who have fought for it, are not prepared to surrender what they have fought for and inspire others in this way to defend it. If a democratic education in Germany is to last, it must be wrought by individual Germans themselves. Thirdly, it is generally agreed that Education in Germany in the future is to become a subject under the control of the individual States and not of the central German Government. If so, it was essential that some tradition of educational responsibility should be built up in the separate States themselves, during the period when they were the only German governments in existence.

One of the most important developments of this second phase has been the increase of cultural and educational contacts between the British Zone and Britain. During the last twelve months the Education Branch of the Control Commission has arranged for over 2,000 Germans to visit this country, Professors and other University teachers, University students, school teachers, children from secondary schools, education officials, those being trained at Training Colleges, leaders of Youth Organisations and of Women's Organisations and others. At the same time many English men and women have been invited over to Germany, to lecture at Universities, Schools, Teacher Training Colleges and Adult Education Colleges ; to participate in Refresher Courses for Teachers and University Vacation Courses ; and to give advice on specific educational problems.

I have said that we are now entering the third phase. We have made it clear that we look forward to Germany having its own government with a proper democratic constitution. It will be no fault of ours if that

Government and Constitution are confined to Western Germany and we look forward to the time when they will include the whole country. When Germany, or Western Germany, has its own Government, the relations between British and German Education will tend to approximate much more nearly to those between two states which are in very close relationship with one another. But the need to assist the healthy elements in German Education will in no way be lessened. Those Germans, who are working now to build up a new spirit in Education in their own country, will need all possible encouragement and support from people concerned with Education in other countries, who have the same outlook. We have already made it clear to the Germans that we are deeply interested in the development of democratic Education in Germany in the future and that we intend to advise and assist them, but that we do not intend to interfere with their educational legislation and administration.

The German universities have proved an exceptionally difficult problem. There is general agreement, at least outside the Universities themselves, that they stand in great need of reform. It is, however, alarming that so many in Germany feel that they are hardly capable of reform. We decided that it would be futile to try to reform the Universities by decrees, altering their constitutions and methods of entry, badly as such alterations are needed. And we felt that it was not the least use to dismiss Professors, who are too reactionary or unrealistic, if there were no suitable young men to replace them, as was unfortunately the case. The first need was to help the younger University teachers who might be expected in due course to lead a movement of reform. Almost every British University agreed to take for at least a year or more young German University teachers. We hope that this experience will give them new ideas about Universities and greater confidence, though we certainly do not want them to try to turn German Universities into British ones. We hope that the number of these visitors will soon be increased and will include some young men and women doing post-graduate research work.

We look forward to a natural strengthening of the educational links between Germany and Britain. But it will not suffice if such relationships exist only between Germany and this country. What is wanted is that Germany should find its place as a member of European civilised society. The task of helping her to do that is one not only for Britain, but for all the nations of Western Europe. I believe that the most important task of all that faces us in the next phase of our educational work in Germany is to foster this development and that it is one that might have very far-reaching effects on the future of our civilisation.

Selection for Universities

The final session of the Section, on September 14, was devoted to a discussion of the difficulties of selecting students for the Universities. As one journal commented on this session, the difficulties were admirably outlined but there was a remarkable lack of confident suggestions for overcoming them. Since the meeting, the Minister of Education has received and has taken some action on a report on *University Awards* by a working party appointed to review the position. It is necessary therefore to emphasise that the following notes are of discussion which took place before this report was published.

The discussion was opened by Mr. J. O. Roach. He began by saying that it was necessary to decide upon the aim of selection. Was it, for instance, to pick people who would make good professional men in later life, or those who would shine in academic research ? No single answer would be satisfactory.

Though criticisms were made of present methods of selecting academic high-flyers, the trouble really began when it came to the not-so-high flyers. When county awards were made to those with an average of 60 per cent. in Higher School Certificate the University was getting nothing of interest to itself, and we might ask whether it was right to select at the lower levels by an exclusively academic examination.

Mr. Roach said that if industry wanted the best brains of the country it must go for them to the university. If we select students for the university we must look for special qualities, different from those for example sought in selection for the Services. In the case of the university selection may be for a three or four years degree course, or for a suitable future research worker, and for training for a suitable and worth-while post at the end of the course. Any attempt to impose from outside some non-academic set of standards might well be dangerous to the academic freedom of the universities. The discontents over present-day academic criteria of selection are centred on (a) over-specialisation at an early age, (b) the scholarship system is not an infallible test of selection. On the other hand the present methods are non-political and satisfy public opinion. Follow-up is required to prove their utility.

There was much criticism of the badness of some State scholars. Lord Lindsay was not satisfied that the State scholarships invariably brought on the right men. He wanted health and personality tested by qualifying examinations held by Local Education Authorities,

and this meant that potential students might have to show a good record in out-of-school activities. For this purpose school records would be very useful if kept in the form recommended by the Ministry of Education. He was not sure that interview boards testing nervous and experienced youngsters would be a good method, and these boards might be too near to the school ; single group testing might be tried instead. If university education is to be expanded, character and leadership should be tested as well as academic suitability.

Mrs. J. L. Stocks said that the highway of education, broadened by the 1944 Act, now needed some traffic control. At present there were two control points. There was selection at 11 + directing some children to the grammar school, with a ' diversion of the rest on to side-roads, leading out into various wildernesses.' There was selection for the last lap at the universities. As a first step she held that in so far as university courses were directed towards a job, they should be transferred to the technical colleges, where they belonged.

The present system, with candidates struggling first to get to the university they preferred and second to get into any university at all, developed a musical-chairs sort of mentality dominated by the fear of having nowhere to sit down when the music stopped. Was this system good for the adolescent mind and character ? As for the selectors, Mrs. Stocks instanced her own college (Westfield). They had examined 422, and interviewed 180 for 60 places. The majority were entered for other colleges, which they often preferred to go to and often did go to. It was a waste of time. Attempting to bring order out of chaos involved certain conflicts with individual liberty. They came up against the sturdy independence of university heads who were determined to select their own candidates ; they came up against candidates who wished to keep their right of trying to reach the university of their choice. Such attempts also conflicted with the view held in Government circles that any system of selection which allowed Oxford and Cambridge to secure the cream of the nation's intellect was in some way undemocratic. She felt that it was only undemocratic if the cream were prevented by social and economic difficulties from rising. If one looked at the quality of life, aesthetic as well as academic, offered by those ancient centres of learning, there was good reason that most young people should want to go there and good reason why the best should get there.

Mr. C. R. Morris said he did not consider the selection of the individual student to be the most important problem. He was more concerned with the kind of school education which the Universities demanded. He thought it was a mistake to ask for the abolition of specialisation. For the universities to require pupils to take a large number of subjects after 15 would be to turn our backs on the greatest advance in democratic education in the last half-century. Two-thirds of sixth-form time should be given to specialist study, and pupils would get more out of the discussion of general problems—aesthetic, philosophical, religious, and so on—if they approached them from a basis of expertness in a particular field.

In general it was to be hoped that in due course the mere fact that a boy came from an appropriate school would be sufficient evidence that he had received a proper general education. In that event examinations in outside subjects could be waived, and examinations in special field subjects would be all that would be necessary, in normal cases, for university entrance. If universities, schools and Ministry really understood one another, such a state of affairs would in due course be brought about.

In the discussion which followed the three main papers Sir Henry Tizard said he knew more about Universities than about schools and he thought that University dons and others should not rely on their personal experiences in judging the problem of selection for Universities. He regarded intelligence and zeal as the two basic necessities in a university student. If intelligence and zeal were wanted, then school education should be left in the hands of the schools. Ultimately reliance had to be placed on the standard of school teachers. If they could not teach well on their own initiative nothing the University told them would make them better teachers. He attached great importance to the interview in selection ; and he thought that, if examinations could be left to the schools, the Universities would pick the best men.

ASSOCIATIONS FOR THE ADVANCEMENT OF SCIENCE

At the annual meeting of the French Association for the Advancement of Science, held at Geneva in July 1948, a resolution was passed which called for the establishment of an international Federation of Associations for the Advancement of Science if, after consultation between the individual Associations concerned, such a development appeared to be practicable and desirable. This proposal is still under consideration by the executive bodies of Associations for the Advancement of Science and is also being studied by Unesco.

In most countries where such Associations were in being in 1939, their traditional activities were considerably reduced and in some cases completely stopped. As a result, this not now generally known how many Associations there are or how they are related to each other. In connection with the proposal that a World Federation might be formed a survey has recently been made and readers of *The Advancement of Science* may find the following notes of interest.

The British Association, founded at York in 1831, is the oldest Association for the Advancement of Science in the world and has provided the model for others. Its founders were to a large extent inspired by a German organisation, the Deutscher Naturforscher Versammlung, later known as the Gesellschaft Deutscher Naturforscher und Ärtze, which was established in 1822, with headquarters in Leipzig, and held general meetings on science in different cities each year.

The American Association, which held centenary celebrations in Washington last year, was founded in 1848. The French Association came next, in 1871 and the Australian Association in 1887. At the time of the centenary meeting of the British Association in 1931 other Associations had been formed and were active in Canada, India, Italy, Japan, Portugal, South Africa and Spain. Later in the 1930's the Chinese Association was established.

To complete the tale it is only necessary to add here that news has been received of the establishment of new Associations for the Advancement of Science in Brazil, Pakistan and Uruguay. The scope and functions of the newest Associations is not completely known at the time of writing, nor is it certain whether they will be able to carry out all the functions of the long-established Associations, but their foundation is welcomed and it is greatly to be hoped that their work will prosper.

With the exception of the Indian Science Congress Association (founded in 1913) all these Associations declare in their names that their object is the Advancement of Science—thus: Association Française pour l'Avancement des Sciences, Asociacion Espanola para el Progreso de las Ciencias, Societa Italiana per il Progresso delle Scienze. In different countries this object is achieved in different ways, but a general idea of the scope of the work they do may be obtained from the following extracts from the rules of some.

British Association.

> 'To give a stronger impulse and a more systematic direction to scientific inquiry, to promote the intercourse of those who cultivate Science in different parts of the British Empire with one another and with foreign philosophers; to obtain more general attention for the objects of science and the removal of any disadvantages of a public kind which impede its progress.' (1831.)

On the establishment of a Division for Social and International Relations of Science in 1938

> 'with the purposes of furthering the objective study of the social relations of Science and of extending and maintaining international interests in this field,'

the British Association declared an interest in an aspect of science which had not previously been generally accepted as within the scope of the Association.

American Association.

> 'By periodical and migratory meetings to promote intercourse between those who are cultivating Science in different parts of the United States, to give a stronger and more general impulse and a more systematic direction to scientific research in our country, and to procure for the labours of scientific men, increased facilities and wider usefulness.'

These objects were later enlarged to include new responsibilities compatible with the growing rôle of Science in the advancement of civilisation, thus:

> 'to further the work of scientists; to facilitate cooperation among them; to improve

the effectiveness of Science in the promotion of human welfare ; and to increase public understanding and appreciation of the importance and promise of the methods of Science in human progress.'

Australian Association.

'. . . the advancement of knowledge and the promotion of a spirit of cooperation between scientific workers and scholars and those in sympathy with Science scholarship generally, especially in Australia and New Zealand.'

Indian Association.

'. . . the advancement of Science in India by the annual holding of a Congress and the doing of all such things as are conducive to the above object.'

South African Association.

'To promote the intercourse of Societies and individuals interested in Science in different parts of South Africa ; to obtain a more general attention to the objects of pure and applied science, and the removal of any disadvantages of a public kind which may impede its progress ; to give a stronger impulse and a more systematic direction to scientific enquiry and research.'

In countries other than those so far mentioned there are or have been organisations of somewhat similar scope and it is possible that they, with the well-established Associations for the Advancement of Science and the younger ones which have, as yet, to make their influence felt, might somehow be federated into a world organisation. At the present time the only Associations which are in regular contact with all the others are those in Australia (including New Zealand), Britain, Canada, France, India, South Africa and the United States. What follows relates mainly to those seven.

The characteristics which distinguish Associations for the Advancement of Science are that they are national and comprehensive. In each country there are national scientific societies or academies which deal with one subject only, or with a narrow group of subjects, or which, dealing with a wide range of subjects, are (like the Royal Society) limited as to membership by election on the basis of eminence. There are also provincial societies and organisations which deal with a wide range of subjects and whose membership is open without scientific qualification. Associations for the Advancement of Science differ from all other Associations by being national, by including all the natural and social sciences within their interest, and by accepting as members people with modest scientific attainments or with no other qualification than an interest in Science. The Associations are further characterised, with slight exceptions (*e.g.* in French Canada) by the holding of annual meetings in different large centres each year.

The range of subjects in which the Associations are interested is very wide indeed, their work being divided for administrative convenience into Sections, each distinguished by a letter of the alphabet. The French Association has 26 Sections making 6 ' Groupes.' At the other extreme, the South African Association has 6 Sections, and the others fall between—thus : Australia and New Zealand (16), United States (15), Britain (13), India (12) and Canada (8). All branches of pure and applied Science come within the scope of all the Associations with one main exception. By agreement of long standing with the British Medical Association the British Association has no Medical Section and touches the medical field only indirectly through the Section of Physiology. None of the other Associations except the Canadian (which does not in any case claim to be comprehensive) suffers such a limitation. The Australian Association, for example, has one Section for Medical Science and National Health and one for Veterinary Science.

The objects of Associations for the Advancement of Science may be briefly restated thus :

(i) To promote scientific enquiry.
(ii) To promote intercourse between men of science.
(iii) To work for the removal of impediments to the progress of Science.
(iv) To improve the effectiveness of science in promoting human welfare.
(v) To increase public understanding of Science.

In varying degrees in different countries these objects have been and continue to be achieved by means of research, meetings, publications and advocacy.

Research appears to be a diminishing function of the Associations and no major contributions are now expected from projects which they finance. The Associations have an honorable history in this connection and have added greatly to the advancement of knowledge largely through the unpaid services of their members supported by small grants for correspondence and equipment. Nowadays, however, with the development of public recognition of the value of scientific research (which the Associations have helped to bring about) and the more ready availability of grants for research (notably from Governments), the original work which Associations for the Advancement of Science can sponsor is only a small proportion of the sum total

of scientific research. Their present usefulness is to identify problems (especially problems affecting more than one subject) on which original research is required and to bring such problems to the notice of others by whom action might be expected.

The main activities of the Associations and those on which their reputations have been mainly based, are the great annual meetings. These may be attended by 5,000 to 6,000 people as in America, by 2,500 to 3,000 as in Britain or by 100 as in Canada and South Africa and in the scientific life of each country they are unique events.

The programmes for these meetings, which usually last for a week, include scientific transactions, social functions, tours and visits, blended in varying proportions in the different countries. The scientific transactions consist mainly of communications to the Sections which meet separately or jointly, addresses by Presidents, discussions, symposia, public lectures and so on, the principal address being that of the President of the Association. In Britain and some other countries the whole programme is arranged and sponsored by the Associations : in America the affiliated Societies hold meetings of their own in the same city concurrently with those of the Association.

At the meeting of the American Association in 1947 some 2000 papers were presented. By comparison, the 300 items in the programme of a British Association meeting seems small, and the number of contributions in the programmes of other Associations may seem smaller still, but the scientific value of those meetings must not be judged by statistics alone, and it is quite impossible to assess the practical value of the innumerable contacts which are made within and, equally important, outside the formal sessions.

The following are some of the characteristics of the annual meetings :

(i) There are no other regular occasions when so many scientists, from so many branches of pure and applied science, meet to discuss problems of current interest ;

(ii) The programme provide the widest possible variety of interest for specialists and non-specialists ; and non-specialists include all men of science who find it difficult to keep abreast with subjects other than their own. The meetings enable specialists to view their own subjects in the general setting of science as a whole ;

(iii) Quite apart from the scientific programme, in which the majority of the members can take but little part except as listeners, there are countless opportunities for making individual contacts of a kind which have frequently been known to lead to the solution of personal and technical problems and to life-long collaboration and friendship. For those whose scientific work isolates them from Universities and other large centres of scientific research and development, and particularly for young people who have yet to develop themselves, such opportunities can hardly be over-rated ;

(iv) For intelligent laymen interested in the progress of Science an annual meeting of this kind offers an unrivalled opportunity for meeting men of science on terms of equality in an atmosphere of informality, for instruction and for information.

The coming of an Association for the Advancement of Science into any city is a great event in the life of that city and arouses considerable interest in the immediate neighbourhood. Nor is the interest confined to those who attend the meetings or public lectures. Newspapers and other journals find in the programmes an abundance of material for articles and reports which reach a vast public audience. The press cuttings of the British Association meetings, for example, have recently amounted to something in the region of 20,000 single column inches in papers of severely restricted size. By itself this figure may be meaningless to many, but it has been judged by an expert to be almost half as large again as the volume of press reports of the annual conferences of the major political parties.

It is usual, also, for the radio companies to arrange live and recorded broadcasts by scientists and commentators and through this medium the meetings make an impact on many millions of people.

The scope for disseminating scientific information and for increasing the public understanding of science has increased tremendously since meetings such as these were first arranged. But with new opportunities have come new responsibilities in the selection of subjects and speakers.

Apart from topical and ephemeral reporting of the proceedings (which is at the discretion of the agencies concerned), arrangements are made for the publication of prepared contributions. Only a fraction of these can be reported in the journals of the Associations, and many are published elsewhere. The traditional publication of Associations for the Advancement of Science has been an annual report : but in several instances this has been replaced by other

publications. *Annual Reports* are published by the Australian and New Zealand Association, the Indian Science Congress Association and the South African Association. The A.N.Z.A.A.S. is also responsible for a bi-monthly *Australian Journal of Science* with a supplement *Australian Science Abstracts*, and the South African Association has recently produced a monthly bulletin *South African Science*. The British Association publishes *The Advancement of Science* quarterly and the French Association a quarterly revue *Sciences*. The Italian Association publishes *Scienza e Tecnica* monthly and *Las Ciencias* is the quarterly journal of the Spanish Association. The American Association now owns *Science* (26,000 copies weekly and the equivalent of *Nature*), and *Scientific Monthly* (16,000 copies). The A.A.A.S. also publishes periodically reports of special symposia, and is responsible for *American Men of Science* (Who's Who).

The effective strength of the Associations has not been estimated and it is doubtful whether it can be. For this there are a number of reasons which may be better understood by a brief consideration of organisation.

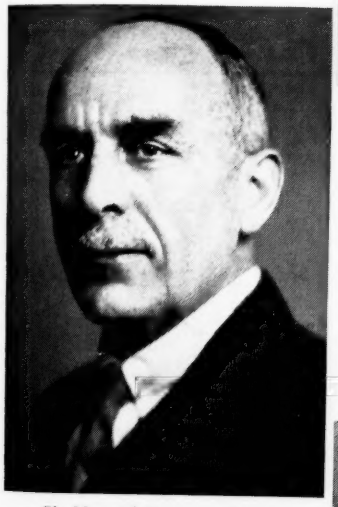
Associations for the Advancement of Science are non-commercial, non-political associations of scientists and people interested in science. Their membership is open without restriction as to scientific qualifications : but in each there is provision for the election, appointment, or other recognition of members who have attained eminence later as scientists. Neither Membership (which may last for short periods only) nor Fellowship (where it exists) carries any professional status. In addition to individual membership there are various degrees of group membership for which there is no standard pattern in the different countries. Full membership includes corporate membership of firms and other organisations which subscribe to the funds of the Associations ; and affiliations of various kinds by which other scientific organisations are identified with the work of the Associations, often without the payment of subscriptions. The French Canadian Association is primarily ' a federation of Societies which have as their object the expansion and the popularisation of Science.' The American Association has affiliated to it or associated with it over 200 national and other bodies. The British Association has associated with it over 150 scientific societies who send delegates to its annual meetings.

Whereas it is possible for a professional organisation with a rigid system of exacting dues from its members, to state categorically the strength of its membership, it is quite impossible for Associations for the Advancement of Science, who derive considerable ephemerical support from individuals participating in single meetings, and whose strength is based in part on the invisible support of members of affiliated societies, to state their numerical strength at any particular time. In *Summarised Proceedings and Directory 1940–48* the American Association have published the names of 40,000 people who were members of the Association *between July 1, 1940, and December 31, 1947*, and the membership for 1947 is shown as 33,442. It is also estimated that the combined membership of the Association and its affiliated Societies is over half a million people. No comparable figures are available for any other Association, but it may be roughly estimated that, by the end of the 5th post war meeting to the British Association some 6,500 people will have subscribed at one time or another in 5 years. In any comparison which may be drawn between this figure and that of the membership of the American Association it should be noted that subscribers to *Science* (26,000 weekly) are included in the membership of the American Association while there are many subscribers to *Nature* who are not members of the British Association.

In spite of the difficulty of assessing the numerical strength of the Associations, it is clear that by their representative nature and by the support they receive from a high proportion of the most eminent among men of science in each country, they are powerful democratic organisations in the world of science. Perhaps their most important functions in the future are to serve as integrating factors in the midst of ever increasing diversity and specialisation in science and to increase the public understanding of the methods and objects of science.

Printed in Great Britain
SPOTTISWOODE, BALLANTYNE & CO. LTD.
London and Colchester

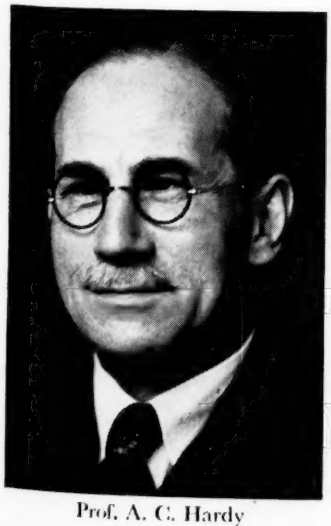
Sir John Russell



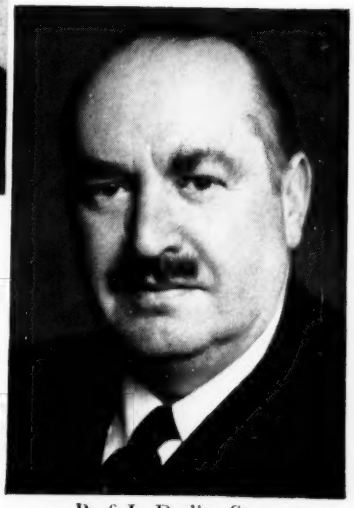
Sir Harold Spencer Jones

Sir Alfred Egerton

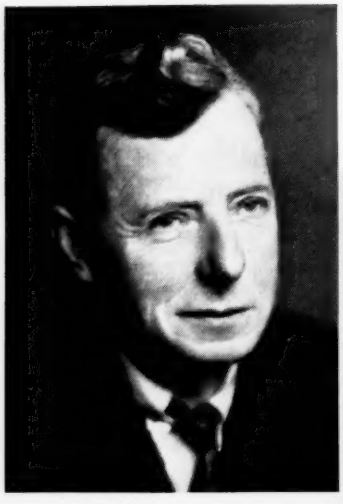
Prof. W. J. Pugh



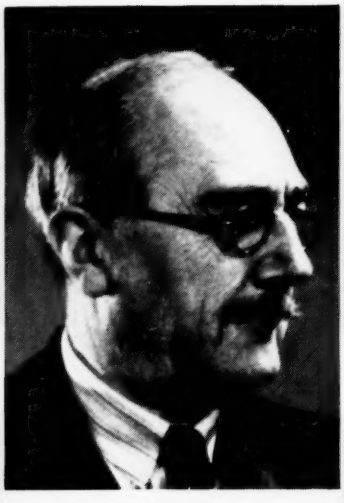
Prof. A. C. Hardy



Prof. L. Dudley Stamp

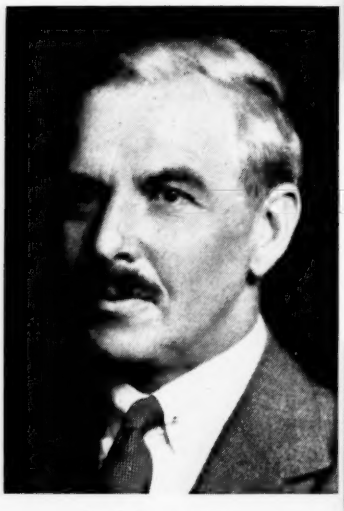


Sir Alexander Gray

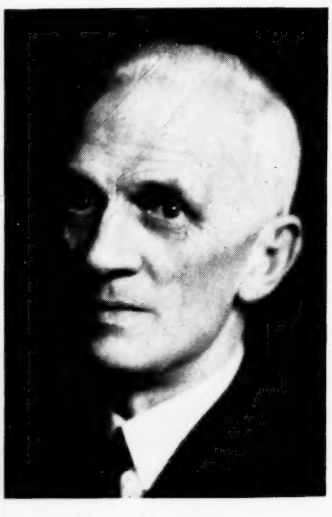


M. C. Burkitt

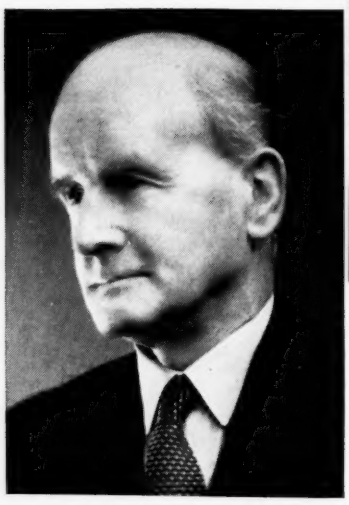
Sir Arthur Fleming



Prof. R. A. Peters



Sir Godfrey Thomson



Sir Fred Clarke

Prof. Lily Newton

Prof. N. M. Comber